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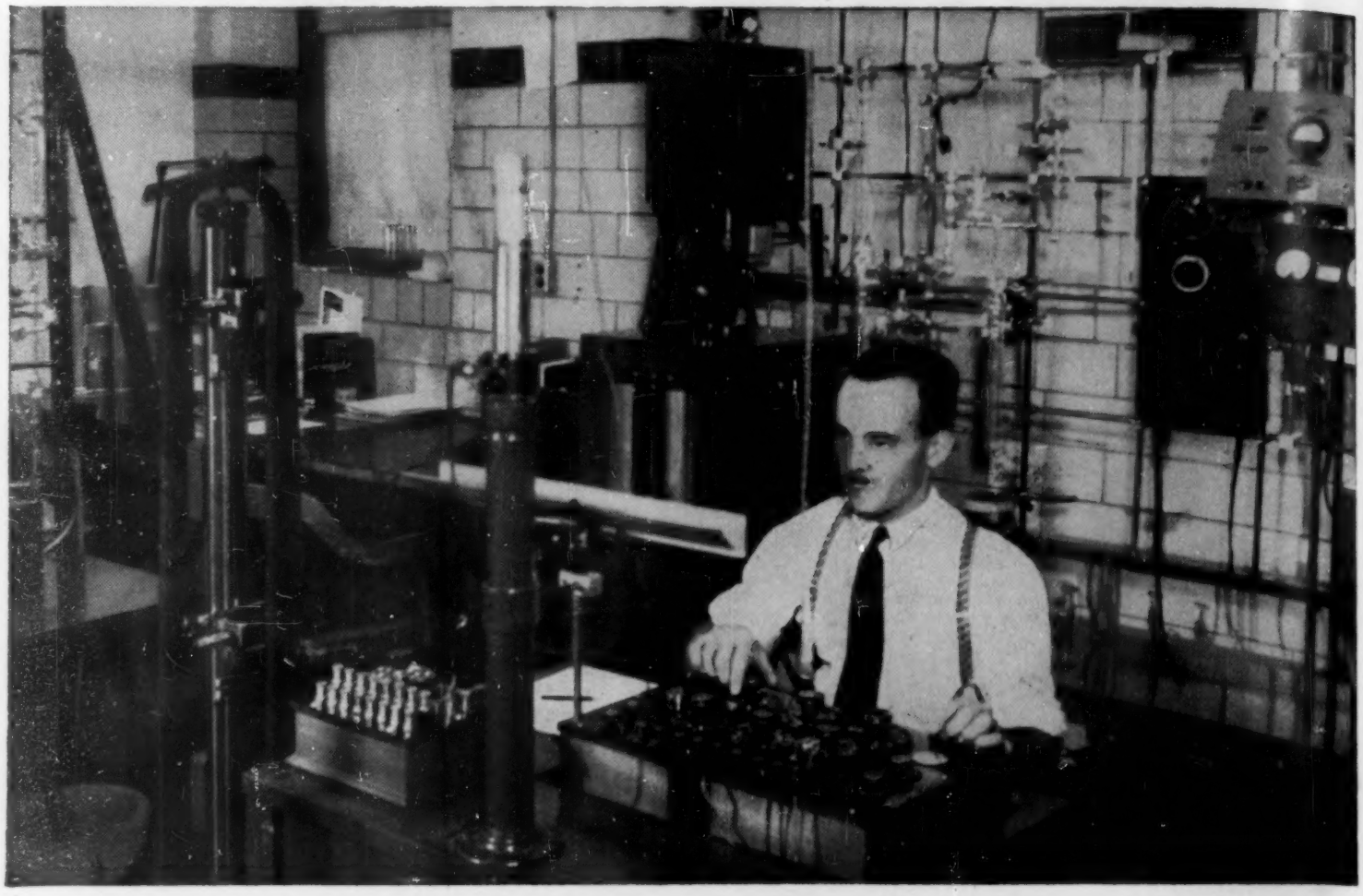
December 17, 1948

Science

The Michelson Laboratory at Inyokern

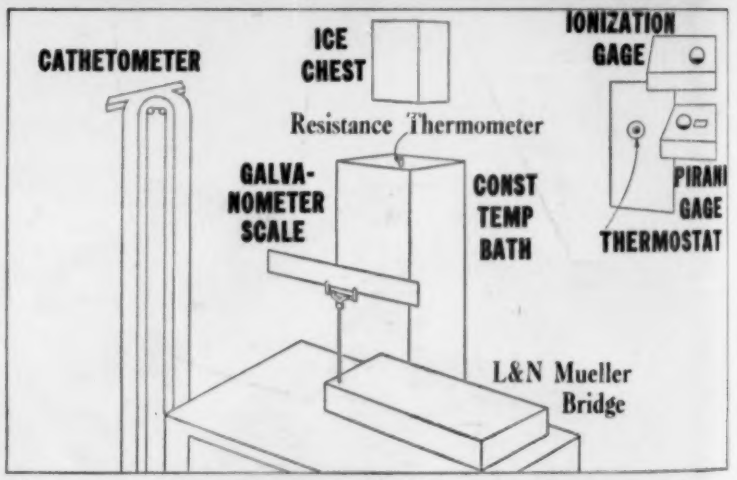
(See page 700)

Mueller Bridge for Measuring Temperature During Precise Vapor Pressure Studies



Apparatus for precise measurement of vapor pressures, photographed above and diagrammed at right, shows use of manometer, cathetometer, and G-2 Mueller Bridge at Bureau of Mines, Bartlesville, Okla. Manometer and sample container are immersed in the constant temperature bath. Before the compound to be studied is introduced into the container, the system is evacuated, using the Pirani gage to indicate pressure down to one micron and the ionization gage for lower pressures.

During measurements, the cathetometer is used to read the vapor pressure as indicated by the mercury manometer. The thermostat automatically regulates the bath temperature, and the Mueller Bridge precisely indicates temperature of the sample.



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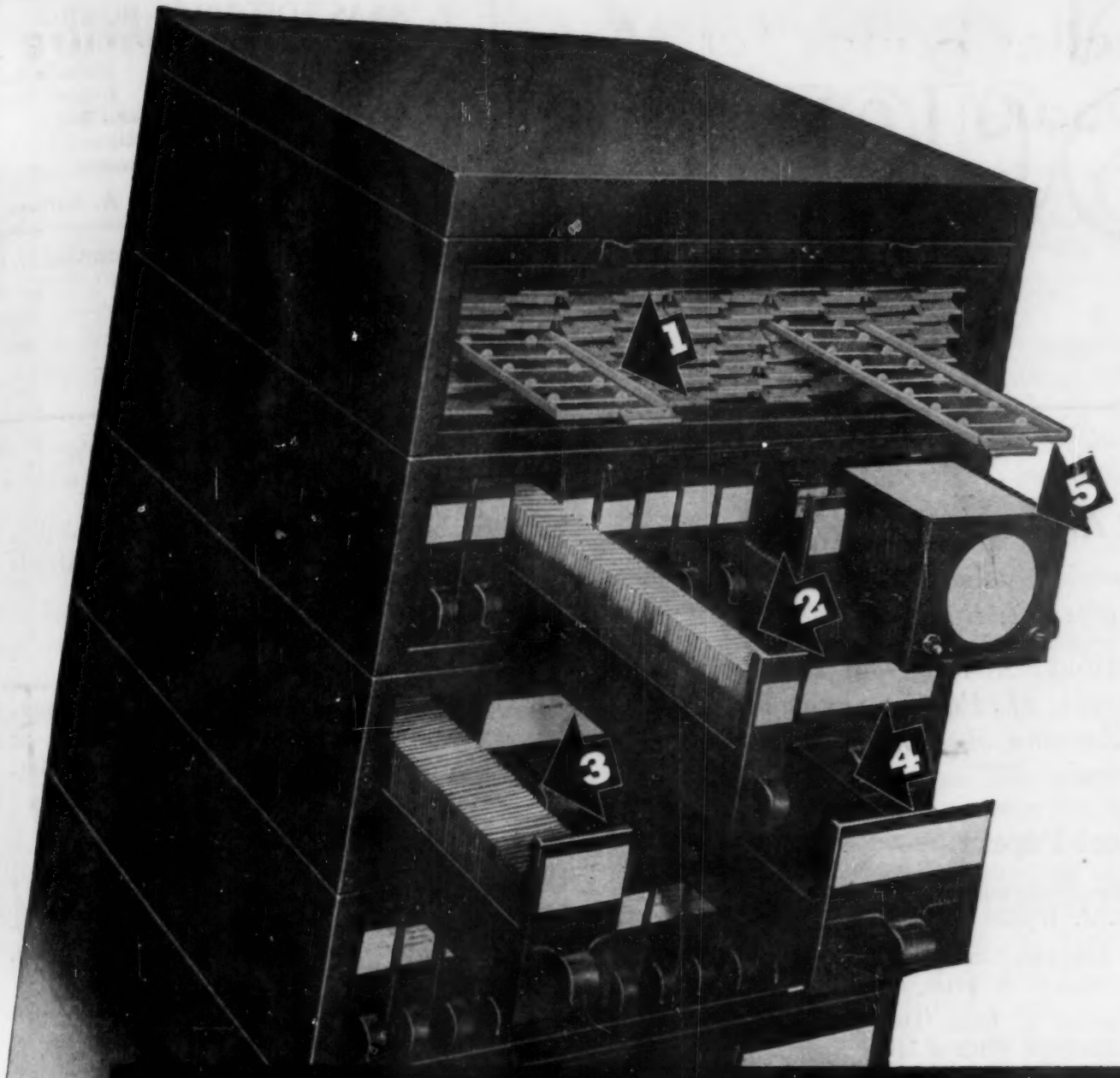

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(*Cover photo by U. S. Navy.*)

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The Atomic Nucleus, A New World to Conquer

I. I. Rabi
Department of Physics, Columbia University

THE ELECTRICAL CONSTITUTION OF MATTER—that is, the fact that matter is made of constituents which are electrically charged positive and negative—was clearly understood only at the turn of the last century. The fundamental fact of atomic structure, that the atom was made up of a central positive core, the nucleus of the atom, which was positively charged and surrounded by electrons charged negatively, was realized only after 1911 from the great work of Rutherford.

However, it was not until after the work of Bohr, Einstein, Schrodinger, Heisenberg, Pauli, and Dirac that we had adequate intellectual tools to understand atomic structure. By the end of 1928 the job was complete. The fundamentals had been understood, and the structure of the atom was a problem which, in principle, had been solved. The atom had been conquered, but conquest and consolidation are two very different things.

Newton, almost 300 years ago, gave the fundamental theory of the solar system and celestial mechanics, yet there are astronomers and mathematicians working on these very problems even today. One hundred years from now there will be physicists, chemists, and engineers working on important problems of atomic and molecular structure.

Long before the fundamental principles of atomic structure had been understood, very important advances had been made both in theory and application, because practical results do not depend on detailed knowledge of the basic laws.

The subject to be discussed here, however, is not the structure of the atom but the atomic nucleus. In assessing our present position on this problem and forecasting the future, however, there is much we can learn from the development of our attempts to understand the atom. Let me sketch very briefly the fundamentals of the problem.

If an atom of uranium were magnified 1,000,000,000 times, it would be the size of a basketball, and if its weight were increased correspondingly, it would weigh about a ton. If one were to examine it carefully, one would at first sight see nothing at all, but on very close inspection one would find 92 tiny particles, each much smaller than the point of a very fine needle, moving with enormous speed, approximately inside the confines of the basketball. These are the electrons. Altogether these electrons, small as they would appear, would weigh one-half pound.

In the center one would discover a speck of dust about 1/1,000 of an inch in diameter. This is the nucleus of the atom. Its weight or mass would be a ton, less one-half pound, of course, for all the electrons put together. If we take, with Einstein, the famous relations $E = Mc^2$—that is, energy is proportional to mass—we see that almost 99.99% of the energy of matter is locked up in the nucleus.

The useful energy we have had available up to the present from fuels such as oil, coal, or food has been chemical energy and generally less than one billionth of the total conceivable energy which is locked in the atom and more particularly in the nucleus. These numbers stir the imagination. They are inspiring and frightening, especially if we remember Hiroshima.

I am not, however, predicting the release of these stupendous powers. We have a long way to go before we can even begin to assess the validity of such speculations. Let us examine further this speck of dust we called the nucleus of the uranium atom.

Looked at more closely, it would turn out to be comprised of 238 objects, 92 protons all positively charged and 146 neutrons. I did not pick uranium 235 because that is fissionable material and is classified secret. The protons are all positively charged and have the same charge as the electrons. The neutrons have no charge at all.

We now come to the fundamental question: What forces keep this conglomeration of protons and neutrons together against the mighty repulsions of the protons for one another? What force keeps these nuclear particles which move at tremendous speeds from flying apart in less than one billion billionth of a second? I do not know, nor does anyone else in the whole world.

There are some charming speculations which may contain some grains of truth. I will tell you something about them, but first I must say that our ignorance is not entire. Although the why of nuclear forces is not known, we have a very definite notion about the magnitude of these forces. Otherwise, the atomic bomb could not have been made and we could not be seriously discussing the use of nuclear energy for the production of power. Application of scientific

This paper is based upon material presented in an address at the dedication of the Laboratory of Nuclear Studies at Cornell University, October 7, 1948.

discovery does not have to wait on complete understanding of the whys and wherefores.

The utilization of atomic energy, whether for warfare or the greater arts of peace and healing, does not await a great basic discovery. The fundamental science is at hand, and it is a question for the engineer, the chemist, the metallurgist, and applied science in general.

At this dedication of the Institute for Nuclear Physics we are concerned with much more fundamental questions which look beyond the immediate practical problems of today but which may bring the headaches of the future. We will now proceed from what may be considered the more or less well-known to what is known only partially and on into the unknown.

The real reason for basic research is to expand the boundaries of knowledge pure and simple. It is an expression of the human spirit. This passion for new knowledge, for the exploration of nature, is strong in some, easily controllable in others, and in many people completely absent. Various societies have differed in this respect. The Athenians were passionately devoted to the search of abstract knowledge, but the Spartans were quite indifferent.

Fortunately, we are living in a time in our country when the interest in scientific research and discovery is mounting very rapidly. This new Institute for Nuclear Science is one of the many expressions of this interest. The great telescope on Mount Palomar is another. All over the country great new laboratories are arising in all fields. Schools of art and music are multiplying. The country is growing up, and some of the energy which went into the conquest of this continent is turning toward intellectual and artistic endeavor. We may see the dawn of a Golden Age. Perhaps it has already come and we are no more aware of it than the Athenians in the time of Pericles.

Let us return to the examination of the atomic nucleus just for the sheer pleasure and interest of it. To study an object as small as the atomic nucleus is even more difficult than it sounds. In the first place, you know that one can see smaller objects with the ultraviolet-ray microscope than with an ordinary microscope using visible light, the reason being that the wave length is shorter in the ultraviolet. More recently you have heard of the electron microscope, with which one sees things even smaller, because electron waves can be utilized which are very much shorter. The large synchrotron which is now nearing completion will produce electron wave lengths and gamma rays which are a sort of supershort ultraviolet, of approximately the size of the nucleus. In a certain broad sense the plan is to take a "look-see" at the atomic nucleus with these extraordinarily powerful instruments.

What will Prof. Wilson and his colleagues see? If he knew, he would not have built the instrument, but we can conjecture some of the strange things he might see and study. In the first place, the energy of the radiation, although compressed in volume, comes in such enormous packets (about 300,000,000 v, compared with 3 v of ordinary light) that mostly chips in the form of protons and neutrons will come out of the nucleus. These chips will interest them enormously but will probably not be the main show.

The chief phenomenon will be in the class which has already been observed in cosmic rays and in the large synchrocyclotron at Berkeley. When these ultra-high-energy particles strike a nucleus, new particles come out which were not supposed to be there in the first place. They cannot be within the nucleus for reasons which would be too lengthy to set forth here. Yet they come out of the nucleus under the extreme condition of high-energy impact. The only possibility is that they are created then and there, on the instant, out of the energy of the collision.

This fascinating phenomenon was first observed about 15 years ago by Carl Anderson in Pasadena. When gamma rays of over 1,000,000 v of energy strike an atomic nucleus, a pair of electrons comes out once in so often, one positive and one negative. Vice versa, a positive electron and a negative electron can combine, leaving nothing but gamma radiation which is pure light energy.

In the big Berkeley cyclotron it was observed only a few months ago by Lattes and Gardner that when a 400-Mev nucleus of helium struck a carbon nucleus, a new particle appeared, perhaps identical with one previously observed in cosmic rays by Powell and his group in Bristol, England, about a year ago. This new particle has been called a pi meson. It is about 300 times as heavy as an electron and can have either positive or negative charge. The pi meson does not last very long, only about one hundred millionth of a second, and then it turns into two other things. One of these is another kind of meson of about 200 electron mass units; the other partner is at present unknown.

This phenomenon was first observed in cosmic rays by the Bristol group about 18 months ago, although we have no real assurance that the Berkeley and Bristol phenomena are identical. The Cornell synchrotron is therefore coming into existence at a very exciting time and is bound to play an important role of discovery. The mu meson, which may be identical with a particle which Anderson in Pasadena and Street of Harvard found in cosmic rays about 1

years ago, does not linger with us very long either. After about a millionth of a second it turns into an electron and something else which is also unknown.

What do these phenomena mean? It is far too early to tell. No one knows how many more particles will be found in the next few years, after the new machines are in operation, or perhaps in the next few months or days.

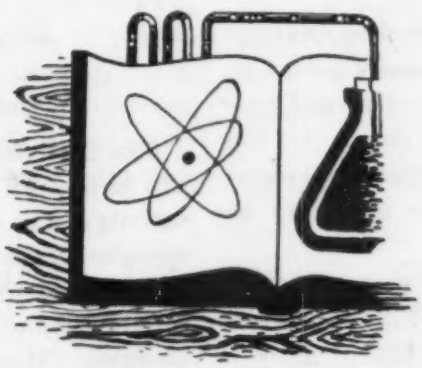
Strangely enough, some of these discoveries were foreshadowed in 1935 by the Japanese theoretical physicist, Yukawa, who was then about 27 years old. He reasoned from the fact that nuclear forces were short range like the cohesive force of a glue which is very strong on close contact but disappears on a small separation, that the forces could not be electrical in nature, since these are long-range forces like gravitational forces. On the other hand, if one postulated that a proton or neutron in a nucleus could spontaneously emit a massive particle which could be absorbed by another proton or neutron, and vice versa, such short-range forces could be explained. Shortly afterward, following this same lead, Anderson and Street independently discovered the mu meson, which could be such a particle but isn't. Perhaps the pi meson is this Yukawa particle. It has been suggested with justice that they be called Yukons.

We see that somehow there may be a connection between these new particles and nuclear forces. Why there are so many, why they should disintegrate so quickly and spontaneously, we do not know. We do not know how many there are, or just how they behave in the neighborhood of a nucleus, or anything solid about them really. The young men and women here who expect to be physicists will have plenty of problems to study.

In conclusion I wish to tell you of the most charming new particle of all, the neutrino. This particle has never been observed, but, like the God of the philosopher, if it did not exist, it would have to be invented. It comes about in this way: Some nuclei, like rubidium or potassium, spontaneously emit electrons and change into another kind of nucleus. Yet there cannot be any electrons within the nucleus itself. They are just created and come out. On the other hand, they do not all come out with the same energy, even though there is a definite energy difference between the energy of the original and final nucleus. This is more than tragedy, because the law of the conservation of energy, without which we would not know how to turn around in physics, says that any energy lost must appear in some other place. That is where the neutrino comes in; it is a particle invented to carry off the missing energy in order to keep the books straight. There is a similar law about spin, and the neutrino takes care of that, too. It is a most convenient little gadget.

After it had been invented, consequences as to its properties could be drawn fairly easily. The most striking property is that it has no mass whatever. It interacts with matter so slightly that it could pass right through the earth in its thickest part without hindrance. For this reason there is no known way of detecting it. It is merely the subject of the verbs "to be" and "to spin."

I hoped in this talk to show you that we physicists do not know everything, that this is not a depressing subject, hopelessly involved in atomic warfare, but a great and exciting, civilized, intellectual adventure. The new Institute of Nuclear Physics puts Cornell right in the center of this wonderful life.



The National Academy of Sciences:

Abstracts of Papers Presented at 1948 Autumn Meeting, Berkeley, California

New Systematics in Alpha-Radioactivity

Glenn T. Seaborg

University of California, Berkeley

A great number of new nuclear species have been prepared within the last few years in the region of the natural radioactivities, permitting a more extensive view of the nuclear properties here. In particular, regularities in alpha-decay properties can now be seen more clearly. More recently, work in this laboratory with the 184-inch cyclotron has further extended our view of alpha-decay properties by identifying isotopes of the elements in this region far on the neutron-deficient side of beta-stability.

One particularly interesting correlation of these data shows that each element from bismuth to curium has a parallel increase in alpha-energy with decreasing mass number, starting with the heaviest isotope of each. In the cases of thorium and uranium this regularity extends through 8 measured isotopes covering mass number ranges of 9 and 11, respectively. In the lower elements a different phenomenon appears. Although the heaviest isotopes of each show the trend noted above, the alpha-energies begin to decrease with decreasing mass number beyond a particular point. The isotopes showing maximum alpha-energy are, for the respective elements, Bi^{211}, Po^{212}, and At^{214} or At^{213}, the latter being unknown. This trend was noted some time ago for polonium isotopes. However, at still lower mass numbers for each element the initial trend of increase in alpha-energy with decrease in mass number is resumed.

The Thermodynamics of the System KHF_2, KF, HF, and the Nature of the Hydrogen Bond in KHF_2

Kenneth S. Pitzer and Edgar F. Westrum

University of California, Berkeley

(Introduced by W. M. Latimer)

It was discovered by Pauling and confirmed by Giauque and others that the proton is not symmetrically placed in many O—H—O hydrogen bonds. The shortest and presumably the strongest hydrogen bond known is the F—H—F bond in the ion HF_2^-. The present investigation considered the crystal KHF_2 and the symmetry or asymmetry of proton location therein.

By a sequence of thermal and chemical equilibrium measurements involving the reaction $KHF_2 \rightleftharpoons KF + HF$, it was established that no residual entropy of proton location remains in KHF_2 at the absolute zero. The thermal behavior of KHF_2 shows no low temperature anomaly which might be associated with a long-range ordering of unsymmetrically located protons. Consequently, it is concluded that the proton in the FHF^- ion is centrally located. The relationship of this conclusion to spectroscopic and other related properties of KHF_2 is discussed.

Relative Rates of Hydrolysis of Urea Containing C^{12} and C^{14}

Albert L. Myerson and Farrington Daniels

University of Wisconsin

Urea containing radioactive carbon was synthesized by a simple method which involved releasing carbon dioxide from barium carbonate, mixing with ammonia at a low temperature, driving the resulting ammonium carbonate into a capillary tube, sealing off, and heating for two days at 135°.

About 0.1 gm of the urea containing both C^{12} and C^{14} was dissolved in 20 cc of buffered solutions ranging from pH 4.9 to pH 6.7. The urea in the presence of the enzyme urease hydrolyzed to give ammonia and carbon dioxide. The carbon dioxide was swept out with a rapid stream of purified nitrogen and absorbed in standard barium hydroxide solution. The course of the reaction was followed by back-titration of barium hydroxide solution, and samples of carbon dioxide from the early, middle, and late periods of the reaction, precipitated as barium carbonate, were analyzed for C^{14} with a Geiger-Müller counter. The carbon dioxide evolved in the latest stages of the reaction was found to be depleted with respect to radioactive C^{14}. If the difference in zero-point energy of C^{12} and C^{14} bonds in the original urea were the *only* factor affecting the competing reaction rates, the urea containing C^{14} should have reacted more slowly, leading to an enrichment rather than a depletion of C^{14} in the late stages of the reaction. The possibilities of other factors are considered.

Some Results Obtained With the 184-Inch Cyclotron

Edwin M. McMillan

University of California, Berkeley

The first two years of this great machine's operating life have been marked by a wide range of experimental activity. The cyclotron provides nuclear projectiles with energies up to nearly 400 Mev; when these strike other nuclei, many things happen, some of them being strikingly different from phenomena previously observed at lower energies. Most of the processes seen can be described in terms of rearrangements of the neutrons and protons that are supposed to be the fundamental constituents of nuclei, and a detailed study of these processes has already led to a considerable clarification of our ideas concerning the forces that act between these particles. In some

cases, however, different particles come out. These have been found to be mesons, previously seen only in the cosmic rays. Here the interpretation is by no means so clear, and perhaps the next great advance in knowledge will come when further work has shown the true nature of these events.

A Progress Report on the Cyclotron

Ernest O. Lawrence

University of California, Berkeley

At the last meeting of the Academy in Berkeley the basic principle of the cyclotron was outlined, and the first experiments with a 4-inch magnet were described. The present paper is a general review of the development of the cyclotron during the intervening 18 years, including the 184-inch synchrocyclotron and the 100-foot betatron, both of which are special applications of the principle of the synchrotron of McMillan and Veksler.

The Berkeley Linear Accelerator

Luis W. Alvarez

University of California, Berkeley

The initial performance of the accelerator was described somewhat over a year ago. At that time the operation was very erratic, and the beam current was about 10^{-11} amp. The reliability of operation now corresponds to that of an average cyclotron and is being improved continuously. About 95% of the time the Van de Graaff injector is operating, 32-Mev protons are available, indicating that the high-frequency part of the accelerator is remarkably free from trouble. In one month a Van de Graaff beam was available 80% of the working hours, and a figure of 90% is expected in the near future. The beam current now averages 10^{-9} amp. A program to increase this to the neighborhood of 1 microamp is now under way and involves four straightforward features: (1) The focusing grids have been made more transparent; (2) the duty cycle of operation is being increased; (3) the entering ions are being bunched into a smaller phase angle by radiofrequency techniques; and (4) a new ion source is being installed. When the improvement factors of these four programs are multiplied together, the result is of the order of 10^3. The research program now under way includes measurements on proton-proton scattering, inelastic scattering of protons, radioactivity, activation thresholds, and nuclear cross sections. The most attractive feature of the machine is the highly collimated external beam (diameter, 3 mm), which is relatively free of background radiation.

The Magnetic Moments of Light Nuclei

Felix Bloch

Stanford University

It has been recognized for a considerable time that one can ascribe to the atomic nucleus a definite value of its angular momentum as well as of its electric and magnetic moments. The first determinations of these quantities were obtained by spectroscopy and were restricted to the nuclei of the heavier elements.

More recently new methods have been developed which are more accurate and which can also be applied to the lightest nuclei. The interest in the results lies in the fact that they are more directly related to the fundamental problems of nuclear forces than those obtained for the rather complex heavier nuclei.

The most important information concerns the magnetic moments of the neutron and the proton themselves, since they represent the elementary constituents of nuclear matter. It has been possible to compare them with an accuracy of one part in 20,000; together with an earlier determination of the proton moment, this establishes each of these moments to within a fraction of one per mil. Closely related to these values is the magnetic moment of the simplest composite nucleus, that of the heavy hydrogen atom. The corresponding measurements reveal deviations from additivity of the individual moments which are significantly related to the symmetry properties of nuclear forces.

Other interesting features have emerged from the measured magnetic moments of the hydrogen and helium isotopes of atomic weight 3.

Recurrent Geomagnetic Activity

Seth B. Nicholson

Mount Wilson Observatory

and

Oliver R. Wulf

U. S. Weather Bureau

Periods of moderate geomagnetic activity, generally called moderate magnetic storms, sometimes recur at 27-day intervals. The rotation of the sun has been suggested as the cause of this recurrence, and extensive studies have been made to discover solar features associated with this type of magnetic activity. In 1942–44 the appearances of certain patches of bright chromospheric clouds at the sun's east limb were coincident with relatively abrupt onsets of recurrent geomagnetic activity. Some recurrent magnetic activity has been most conspicuous in the years preceding sunspot minima, not when sunspots were most numerous. Recurrent series also show a tendency to begin when the moon is farthest from the equator, an effect which may be related to asymmetrical lunar tides in the earth's atmosphere.

Economy of Flight at Supersonic Speeds

Robert T. Jones

Ames Aeronautical Laboratory

(Introduced by J. C. Hunsaker)

The opinion is occasionally expressed that flight at speeds greater than the speed of sound will be excessively wasteful and that such flight is therefore essentially limited, with present sources of propulsion, to military operations. The aerodynamic theory of slender bodies and wings traveling at such speeds indicates, however, that

reasonably good efficiency can be maintained up to moderate supersonic speeds and that the fuel economy in terms of miles per gallon should, with presently available turbojet engines, not fall far short of that achieved by other forms of transportation.

Calculated examples of the air motions produced by wings traveling at supersonic speeds are shown and provide comparison with the air motions produced at normal flying speeds. These comparisons show the origin of the drag which results from exceeding the speed of sound and show how this drag can be minimized by the use of sweepback. Results of such calculations are used to obtain an estimate of the drag and hence the propulsive energy required for aircraft at supersonic speeds. It is found that for efficient flight an airplane of conventional loading must be equipped for operation at an altitude of the order of 60,000 feet. Designing the airplane for high-altitude operation makes it capable of flying slowly at low altitudes for landing.

Rotating Galaxies

N. U. Mayall

Lick Observatory

(Introduced by J. H. Moore)

The study of the internal motions in the extragalactic nebulae, or galaxies, is at present in the broad, exploratory stage. About all that can be learned of their dynamics in a quantitative way is how they are rotating. Furthermore, observations are restricted to the measurement, by means of the spectrograph and Doppler's principle, of the rotational motions in the line of sight. Because of the faintness of galaxies, fairly low dispersion (300–400 A/mm) has to be used, and long exposures (up to 12 hrs) are required to photograph spectra only a few millimeters long. As a result of these circumstances, detailed results have hitherto been published for only 5 galaxies.

In an attempt to expand the small but hard-won body of earlier work on rotating galaxies, the present investigation was undertaken. This report is preliminary and depends upon spectrograms of 31 galaxies, ranging in appearance from the unresolved, nearly structureless "early-type" spirals to the highly resolved, "late-type" spirals. In all cases the slit of the spectrograph was placed on the major axes of the galaxies, and within the low precision of the observations, the spectrum lines are found to be straight and inclined by various amounts among the different galaxies. The range in spectrum line inclinations was from a maximum of nearly $5\frac{1}{2}°$ to $\frac{1}{10}°$, the limit of detection with the means at hand. Although the interpretation of these line inclinations in terms of rotation is fraught with difficulties, because of the large-scale integration of motions when the slit traverses a whole stellar system, there is both theoretical and observational evidence to justify it as a working hypothesis. On this basis, periods of rotation could be computed after the distances to these galaxies had been estimated from (a) red shifts in their spectra or (b) membership in well-known groups or clusters of galaxies whose distances were known from other criteria.

The results of the investigation can be summarized in a single diagram showing periods of rotation according to type of galaxy. For a few early-type galaxies (E7, SO, Sa) periods of rotation range from 1,500,000 to 11,000,000 years, no distinction being made between nuclear regions or main body. The large, amorphous nuclear regions of intermediate-type spirals (Sb) rotate in periods ranging from 5,000,000 to 16,000,000 years; their main bodies, in general, are too faint to be observed as a whole. In late-type spirals (Sc) the nuclei are too small for similar investigation, and it is possible to give results only for their main bodies, which appear to rotate in periods ranging from 17,000,000 to more than 250,000,000 years. In short, while there is a general tendency for the period of rotation to lengthen with advancing type, the dispersion in period among the various types is so large that, at least for the present, averages have little significance. Intrinsic brightnesses (absolute magnitudes) likewise seem to bear little relation to period of rotation.

The Electronic Theory of the Transistor

W. Shockley, J. Bardeen, and W. H. Brattain

Bell Telephone Laboratories, Murray Hill, New Jersey

(Introduced by M. J. Kelly)

The fact that a metal point contact to a crystal of galena will act as a detector of radio waves has long been known. The detection process arises from the fact that the contact is rectifying and passes current more easily in one direction, known as the forward direction, than in the other, known as the reverse direction. The phenomenon of rectification occurs in many other cases in which semiconductors and metals make contact. By analogy with the relationship between vacuum tube diodes and triodes, many unsuccessful proposals have been made over a period of years to incorporate a third electrode in a crystal detector in order to produce an amplifier. This desired result has now been achieved with the development of the transistor, which is based on the new principle described below.

The transistor is similar to a crystal detector except that it has two point contacts very close together rather than one. When the input point, or emitter, is operated in the forward direction, it disturbs the electronic balance in the semiconductor in a certain limited region of interaction, effectively less than 1/100 inch in diameter, in such a way as to give control over the current in the output point, which must make contact in the region of interaction and have voltage in the reverse direction. This control is so effective that power gains of a factor of 100 are obtained.

The disturbance produced in the region of interaction can be understood in terms of the two processes by which electrons carry current in a semiconductor. Both of these processes correspond to imperfections in the complete or perfect electron pair bond structure of the crystal; in the excess process, additional electrons are present over and above those required for the valence bonds, and in the defect or hole process, electrons are missing from the bonds. The germanium used in transistors normally

ntains chemical impurities which cause it to conduct
ly by the excess process, a negligible number of holes
ng present. When the emitter is operated in the for-
rd or plus direction, it draws not only excess electrons
t also electrons from the valence bonds, thus intro-
cing holes which in some cases flow in a thin layer on
surface and in others apparently diffuse into the
y of the semiconductor. The presence of these holes
stitutes the disturbance about the emitter which pro-
es the area of interaction.

Since the holes are caused by a deficit of electrons,
y represent positive charges, and since the output
int is biased in the reverse or negative direction, it
llects these holes. Thus, the current of the output
int, or collector, is increased by the emitter hole current
ich it collects. In addition to being collected, the holes
voke an increased excess electron flow from the point,
d in this way current amplification is produced. Thus,
nges in emitter current produce larger changes in
llector current. Furthermore, since the emitter operates
the forward or low-voltage direction and the collector
the reverse or high-voltage direction, large voltage
plification is produced. This accounts for the power
in.

The transistor is now in limited experimental produc-
on, and research on its application in communications
oblems is being carried out.

Heterochromatic Inheritance

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Such cytological work as is relevant for a genetic study
heterochromatin is reviewed. Heteropycnotic and in-
calary H are distinguished. H is important for mi-
tic division and thus for growth in general. Does H
ve a specific genetic effect different from that of
chromatin? A group of genetic effects (podoptera)
s discovered transforming the wing into a leg-like
ructure. Many different lines were isolated, all com-
rable but different in genetic and morphological detail.
he effect is ubiquitous in *Drosophila*. It is based upon
number of factors located in all chromosomes, which
t like multiple factors. The individual factor acts with
ry low penetrance; combined, the action increases geo-
etrically. It is believed that these factors are mutant
nditions of heterochromatic sections for many reasons;
e few successful localizations point to heterochromatic
gions. Though all the factors have essentially the same
ffect, they are not interchangeable between the lines and
ot allelic. But they show a pseudoallelic interaction.
he penetrance of podoptera is greatly affected by the
-chromosome in a very complicated way. Thus, in one
ne an extra Y in the female reduces penetrance; in an-
ther line the females never show podoptera except in the
resence of an extra Y. A second Y might act in the
pposite direction from a first. Remarkable are the re-
tions to the minutes, most of which act like podoptera.
lso, the pleiotropic effects of both are similar. Some
ther dominants act as pseudoalleles to podoptera. Com-
arison with other recent work favors the interpretation.

Atmospheric Tides

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The atmosphere exhibits tidal phenomena which can be detected through their effect on atmospheric pressure. The main tidal component is a progressive wave following the sun from east to west, with wave crests near 10 A.M. and 10 P.M., local time. The amplitude of that semidiurnal solar tide reaches 1.3 mb at the equator and vanishes, for obvious reasons, at the poles. The corresponding tide in lunar time has also been found, but its amplitude is only 0.09 mb at the equator. The tidal force exerted by the moon is actually greater than that due to the sun and is known to produce lunar ocean tides stronger than those due to the sun. The unexpected strength of the solar tide relative to the lunar tide in the atmosphere has been interpreted as a manifestation of resonance, and dynamical theories have been developed which seem to show that the atmosphere actually has a period of proper oscillation close to 12 solar hrs. However, in order to produce the observed pressure amplitudes the proper oscillation of the atmosphere should at all times be about 11 hrs and 57 min. Such exact tuning is unlikely in view of the considerable seasonal changes in the temperature of the atmosphere.

The present communication purports to demonstrate that the semidiurnal thermal wave accompanying the gravitational solar tide also must lead to a strengthening of the tide, so that a less exact resonance tuning than the one quoted above can account for the observed tidal amplitude.

Investigation of Meteoric Radio Reflections

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Stanford University

(Introduced by F. E. Terman)

Visual techniques have been used for many years to study meteors. Recently radio reflection methods have enabled quantitative data on meteors and their effects in the upper atmosphere to be obtained at a vastly increased pace.

The experiments being undertaken at Stanford University exploit the Doppler frequency shift imparted to a continuous wave radio signal when it is reflected from a moving surface. As a meteor enters the lower ionosphere, it first forms a rapidly extended line of charge, and the initial radio reflection serves to determine meteoric velocities with an accuracy of better than 4%. Detailed analysis of the early part of the echo also serves to determine the radii of the cylinder on ionization. Seconds later, the fully formed cloud of charge produces reflections from which wind velocities and diffusion coefficients in the 60-mile-altitude region can be deduced.

The meteor echoes are conveniently studied using radio-frequencies of the order of magnitude of 30,000,000 cycles/sec, and typically have a duration of about 1 sec. These short bursts of reflected signal ordinarily occur several times per minute, in contrast to an average visual

rate of meteor detection of 10/hr. The great increase in the number of meteors now available for study makes possible a statistical attack on problems otherwise unapproachable.

Studies Relative to a Temporary Revision of *Neurospora tetrasperma* to an 8-Spored Type

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On certain media the dominant lethal *E* complex in *N. tetrasperma* causes abortion in asci which are heterozygous E/e. On a potato steep medium such asci do not abort, so delimit spores. Instead of 4 large spores, 8 small ones are cut out. Of these, 4 are unisexual, and normal *e* and matings give asci with 4 large spores. The other 4 spores have, as cut out, a single lethal *E* nucleus each. Such spores usually die after germination. A way has been found to induce 17 of these *E* germlings to continue growth to produce strains pure for lethal *E*. These strains, when suitably mated with normal *e* strains, produce again E/e asci with 8 spores. It yet remains to find a way to induce the lethal *E* strains to mate and mature ascocarps with asci and spores. Such asci would be homozygous E/E. This would mean that a temporary reversion from 4-sporedness to 8-sporedness may be made permanent.

The haploid number of chromosomes in both the normal *e* and lethal *E* strains of *N. tetrasperma* is 7. Seven is the haploid number in all races of *N. sitophila* examined. These races include conidial as well as nonconidial, protoperithecial as well as those not producing receptive bodies. Neither the mating type nor the presence or absence of receptive bodies is a matter of a difference in the number of chromosomes.

The Evolutionary Significance of Two Synthetic Allopolyploid Species of *Bromus*

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(Introduced by Ernest B. Babcock)

Hybrids between two perennial species of *Bromus*, section *Ceratochloa*, with $2n = 56$ chromosomes, namely, *B. carinatus* and *B. maritimus*, and the annual species of the section *Neobromus*, *B. Trinii*, with $2n = 42$, are in both instances vigorous but sterile. Meiosis in these F_1 hybrids is extremely irregular, the 49 chromosomes forming usually 4–6 loosely associated pairs, but otherwise remaining as univalents. In *B. Trinii* × *maritimus* many of the chromosomes become fragmented at meiosis, and their chromatids often reunite to form chromatin bridges at anaphase. Allopolyploids produced by colchicine treatment of these hybrids are mostly from 70 to 85% fertile as to seed set, and in them chromosome pairing is essentially regular, although a few multivalents and univalents are found. At later stages of meiosis many of the chromosomes lag and become extruded from the microspore nuclei. That microspores lacking one or two chromosomes can function is evident from the fact that in third- and fourth-generation derivatives of the original allopolyploids the somatic chromosome numbers recorded for *B. carinatus-Trinii* range from 93 to 98, and for *B. maritimus-Trinii*, from 96 to 100. Plants with deviating chromosome numbers are as vigorous as those with $2n = 9$ and no relationship could be found between chromosome number and fertility. Observations of these allopolyploids planted under natural surroundings during the past three years indicates that they will be successful in some sites. The behavior of these new allopolyploid species therefore indicates that both the originating and the establishing of new species can now be carried out under conditions of controlled experimentation. Furthermore, they demonstrate the possibility of combining in a single species chromosome sets derived originally from 7 distinct diploid species, and of increasing successfully the chromosome number found in *Bromus* above that known in any natural species of the genus.

Mechanism of Proteinuria

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The factors concerned in the excretion of protein by the kidney are discussed on the basis of experimental observations. Proteinuria was induced in rats by the parenteral administration of rat serum, of various proteins derived from human and bovine blood, of eggwhite, gelatin, and Bence Jones protein, and of renin. The facts are not explicable on the basis of any simple hypothesis. In addition to all the conditions that influence the formation of urine by the kidney, the results of these experiments indicate that it is necessary to take into account, at least, the size of the protein molecule, the permeability of the glomerular membrane, the reabsorption of protein by the tubule cells from the glomerular filtrate, and the digestion within the tubule cells of the reabsorbed protein. More specific methods than any we now possess are needed for the study of the processes of reabsorption of intracellular digestion of protein by the proximal convoluted tubules.

Sexuality in *Chlamydomonas*

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Plus and minus strains of three heterothallic species of *Chlamydomonas* (*C. minutissima*, *C. intermedia*, and *C. Reinhardi*) were isolated in pure culture. Immobile (palmelloid) cells growing on agar become motile about an hour after flooding with distilled water and function sexually by fusing in pairs if cells from clones of opposite sex are mixed. Motile cells of these species retain their motility and sexuality for more than 24 hrs after transfer to darkness. Immobile palmelloid cultures of them, when flooded in darkness, become motile and sexually functional even after storage in darkness for a week.

When inoculated upon agar containing suitable organic compounds and grown continuously in darkness, *C. Reinhardi* becomes motile but shows no sexuality when flooded with water in darkness. Palmelloid cultures grown in darkness and then illuminated for 12–15 hrs

become motile when taken to the dark room and flooded. The three species were grown in blue light (4,357 A) and in red light (6,150–6,900 A). When taken to the dark room and flooded, both the cultures grown in red and those grown in blue light become motile and sexually functional.

These results are not in accord with what Moewus reports for *C. eugametos* and two species interfertile with it. He finds that motile cells lose their motility and sexuality when tranferred to darkness. Palmelloid cultures of species he studied do not become motile when flooded with water in darkness. He also finds that in red light there is only the formation of the precursor of the sexual substance and that blue light is essential for its complete development. It is thought that in the three species herein reported upon the sexual substance is not the mixture of *cis-* and *trans-*crocetin dimethyl esters, as reported for the *eugametos* group by Moewus.

The Miocene Occurrence of *Sequoia* and Related Conifers in the John Day Basin

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Four genera of the family Taxodiaceae—*Sequoia*, *Taxodium*, *Metasequoia*, and *Glyptostrobus*—are represented in the Oligocene and Miocene records of Oregon and adjacent states. All of them are found in rocks of Middle Miocene age in the John Day Basin, within a distance of 60 miles. By contrast, the modern distribution of these trees shows no overlapping ranges: *Sequoia* and *Taxodium* are confined to North America, for the most part on opposite shores; *Metasequoia* and *Glyptostrobus* now live only in Asia, where several hundred miles separate their occurrences in central and in southern China. Their modern habitats differ widely both as to climate and topography.

These genera, together with numerous hardwoods, made their first appearance in the Cretaceous and Eocene floras of Alaska and other northern localities, constituting what is termed the Arcto-Tertiary Flora. In succeeding epochs of the Tertiary period, their ranges were restricted at the north and extended southward; all of them had reached the John Day Basin by Middle Miocene time, involving an interval of about 20,000,000 years. In the ensuing 20,000,000 years they have disappeared from this region as a result of continuing changes in topography and in climate.

Analysis of the past distribution of these conifers, and of their associates both in the fossil record and today, provides a basis for reconstructing many details of their Miocene environments and for explaining their modern distribution.

Mechanism of Immunity in Plague Infections

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Cytological examinations of local subcutaneous depositions of *Pasteurella pestis* in monkeys and mice disclose that in the actively and passively immune animal the bacilli are fixed at the site of injection and multiplication is always less than in the control, nonimmune animals. The factors which affect the multiplication are extracellular and intracellular. Definite agglutination and morphologic changes demonstrable by phase-contrast microscopy affect the majority of the extracellular bacilli during the early phases of the infection in the immune. With the arrival of polymorphonuclear leucocytes, intensive phagocytosis participates in the removal and destruction of the bacilli. In the cytoplasm of the cells of immune hosts the bacterial elements stain faintly. Moderate but definite phagocytosis characterizes the behavior of the leucocytes in the normal animal. *In vitro*, the serum of plasma without cells obtained from actively or passively immune animals definitely suppresses the growth and reduces the number of viable bacilli during the first 12 hrs; in fact, 0.3 ml of serum may sterilize an inoculum of 50 bacilli. The bactericidal action of the serum is apparently selective, as evidenced by the rapid multiplication of a few surviving bacilli after the 12th hr. Bacteriostatic and bactericidal action of whole blood is more marked than that of serum alone. Opsonocytophagic tests indicate that avirulent plague bacilli are more readily phagocytized by polymorphonuclear leucocytes and macrophages than are virulent organisms. A highly efficient phagocytic activity by the macrophage system of the lungs in part explains the striking quantitative reduction of the number of viable bacilli within 12 hrs after exposure of guinea pigs to infective clouds of *Pasteurella pestis*. The mechanism of resistance in plague is dependent on an interplay of antibodies and phagocytic cells which is significantly enhanced in the actively immune animal.

Differences in Physiological Activity of Plant-Growth Substances

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The growth hormone of plants takes part in a far greater number of reactions and processes than was originally expected. It causes cell elongation, root formation, lateral bud inhibition, and parthenocarpic development of fruits, prevents abscission of leaves and fruits, etc. A number of substances, all possessing the same basic molecular configuration, are active in these processes. Structurally closely related substances like 2,4-D are used on a large scale as weed killers. To explain this multiplicity of responses and to understand the differences in quantitative response between plants, it becomes necessary to differentiate between physical and chemical properties of these substances. It has been shown that the difference in the rate of translocation through tissues or the permeability of a substance into cells of different plants may explain apparent differences in activity.

Both indole acetic acid and 2,4-D elicit the same basic response in the pea test. In higher concentrations they exert a purely additive effect when mixed. However, when they are mixed in such low concentrations that neither of them is very effective alone more, the resultant

response is more than twice that which could be expected from a purely additive effect. This can be explained on the basis that at these low concentrations indole acetic acid and 2,4-D actually participate in two different reactions which supplement each other. At higher concentrations either of these two substances can provoke both reactions. Further evidence of the correctness of this interpretation can be given by the use of hemiauxins, which at any concentration can provoke only one of these two reactions.

The Perception of Speech and Its Relation to Telephony

Harvey Fletcher

Bell Telephone Laboratories

This paper describes a method of calculating the number of correctly understood fundamental speech sounds, syllables, words, or sentences when talkers and listeners use a telephone system. The quantities that enter into the calculation are the physical characteristics of the telephone system, the noise conditions at the listener's ear and the proficiency of the talkers and the listeners.

The fraction of such speech sounds which are correctly understood is designated the articulation. A quantity called the articulation index, A, is calculated directly from the physical characteristics and noise conditions. It is related to the sound articulation, s, and the proficiency, p, of the talker-listener combination by the formula:

$$A = -\frac{.53}{p} \log_{10} (1-s).$$

The value of A is the product of four factors: the frequency response factor, F; the volume factor, V; the ear-desensitizing factor, E; and the special distortion factor, H.

The first factor, F, is dependent upon the shape of the response *vs.* frequency characteristic for the telephone system. V depends upon the effective gain in the system compared to the masking level of the noise. E depends upon the maximum response. It becomes less than unity for high gains, because the loud sounds cripple the ear response mechanism so that the listener cannot make such fine discriminations as when loud sounds are absent.

The fourth factor, H, is unity except for special types of distortion. A method of calculating H is given for the following types of distortion: pure tone interference, loud noise interference, nonlinear distortion, frequency shift, frequency multiplication, carbon microphone distortion, and distortion due to caller or listener or both being in reverberant rooms.

A comparison of calculated and observed results is shown for about 150 systems for which the articulation data and the physical characteristics and noise conditions were known. The data for systems which were taken in the Bell Telephone Laboratories correspond to three different periods, namely, 1919–25, 1929–32, and 1935–37. Different groups using different testing lists of syllables and different techniques were employed in each of these periods. A fourth set of data, obtained at Harvard University during the war, emphasized the effects of high levels of noise, and a fourth set of lists and techniq was used.

A method is given for correlating the results of th various tests and for obtaining each kind of articulati from the calculated values of A for each system. Th systems include high-pass, low-pass, and band-pass fil systems; various types of resonant systems, from tho having a very broad response to those having very narr peaks; and systems using carbon microphones of vario types which have been used in commercial telepho systems at different times during the past 30 years. T types of interfering noises used range from pure ton having various frequencies throughout the speech ran to that encountered in an average room and to very i tense noise such as is encountered in airplanes or tan

It will be seen that the methods outlined give resu which are in good agreement with the observed data f this great variety of systems.

On Univalent Analytic Functions

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and

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(Introduced by S. Lefschetz)

If $f(z) = z + a_2 z^2 + \ldots$ is regular and univalent in $|z| < 1$, we say it belongs to class S. The coefficients $a_2, \ldots a_n$ determine a point in (2n–2)-dimensional Euclidean space whose coordinates are the real and imaginary parts of these coefficients. The set of these points when $f(z)$ varies over all functions of class S is a region V_n, topologically equivalent to the closed (2n–2)-dimensional full sphere. The functions of class S which correspond to points of the boundary of V_n satisfy a quadratic second-order differential equation depending on 2n–3 real parameters. Conversely, if a function is regular in $|z| < 1$ and satisfies one of the equations, it belongs to S and corresponds to a point in the boundary of V_n. Special properties of these functions are obtained. Functions which belong to supporting points of V_n are shown to have special properties.

Singularities of Analytic Functions at the Confluence of Two Boundary Conditions

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(Introduced by Griffith C. Evans)

The following problem is discussed:

In a neighborhood of the origin of the x,y-plane, let $\varphi(x,y)$ be continuous for $y \leqq 0$ and harmonic for $y \leqq 0$ with the possible exception of the origin; furthermore suppose $\frac{\partial \varphi}{\partial y} - \varphi = 0$ for $y = 0$, $x > 0$, and $\frac{\partial \varphi}{\partial y} = 0$ for $y = 0$, $x < 0$. What is the nature of the singularity of the origin for $\varphi(x,y)$, resp. for the analytic function $\chi(z)$ of $z = x + iy$, whose real part is $\varphi(x,y)$ and whose im-

aginary part vanishes at (0,0)? Since the boundary condition permits the analytic extension of $\chi(z)$ by reflection on the negative x-axis, one obtains on the positive x-axis a second analytic function designated by $\chi(z)$, as analytic continuation of $\chi(z)$, satisfying the relation

$$(R)\chi'(z) - \chi'(z^-) + i\left(\chi(z) + \chi(z^-)\right) = 0.$$

If used for arbitrary z, (R) permits the analytic extension of $\chi(z)$ into the whole Riemann surface of log z, with $\lim_{z \to 0} \chi(z) = \varphi(0,0)$.

The determination of the singularity of $\chi(z)$ at the origin is of importance in hydrodynamics for the behavior of surface waves near a surface obstacle.

A Functional Analysis of Regional Differences in the Human Fovea

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Under suitable conditions of illumination the central portion of the yellow spot of the retina may be seen moderately well outlined in the visual field. This phenomenon has been independently discovered many times. Maxwell is credited with the first painstaking investigation of it; Helmholtz devoted attention to it; Gullstrand, Dimmer, and others, chiefly German scientists, have studied it. The present paper outlines a standard routine for making such examinations of the central retina and reports some research on it.

The yellow pigment of the macular region absorbs blue light but does not appreciably absorb red. The optimal filter is therefore a purple dichroic passing deep violet-blue and deep red. Such a filter (Roscoe No. 28) is mounted directly at the side of a neutral filter (Wrattan No. 96) with similar over-all density. The filters are used before the eye alternately while the subject looks at the screen of an X-ray viewing box, on the face of which the outlines of the observed fields are plotted. Results are reported for 20 men, age 19–32. The average diameter of the projected entoptic image equals $2\frac{1}{2}°$ of visual angle. The spot is characteristically made up of three zones, two concentric rings and a central disc, the latter averaging 33 minutes in diameter and designated as Area 4. The ring immediately surrounding the disc is designated Area 3, the outside ring as Area 2, and the surrounding visual field as Area 1. Areas 2 and 4 show the same color characteristics, usually reported as purple or some variation, such as red-purple, magenta, etc. Areas 1 and 3 lack this purple character and are usually reported as neutral, exhibiting just brightness. This is the result when looking through the dichroic filter. On shifting to the neutral filter, Areas 2 and 4 appear bright green, as should be expected according to the after-image law; Areas 1 and 3 are again neutral. Individual differences are, of course, observable, both in size and in regularity of regional pattern. The theoretical implications of these and earlier findings are discussed. Research growing out of this foveal analysis is briefly discussed, and this form of examination is recommended as a useful approach in correlating functional and structural studies of the fovea, which is one of man's most prized psychophysical possessions.

The n-Ality Theory of Rings

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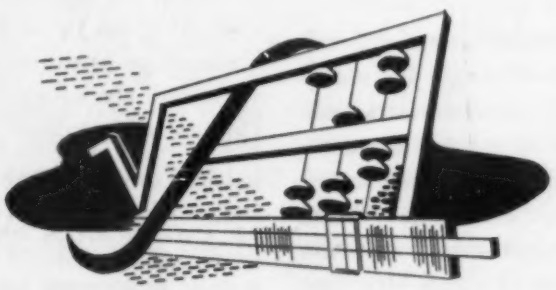
(Introduced by G. C. Evans)

The classic duality theory which is exhibited by Boolian rings (and algebras) is actually a phenomenon (dormantly) inherent in all rings; this *ring duality* theory has been presented and variously developed in a series of previous communications.

It is now shown that this ring duality may itself be oriented within the framework of a unified *general transformation-invariant theory,* in which all concepts of given ring—in fact, more generally, of any kind of operational discipline—are transformed "cogrediently" (or else "contragrediently") with each of an admissible group, K, of "coordinate transformations" in the ring (or discipline), in a manner similar to the traditional cases (which are subsumed in the general theory), e.g. tensors, matrices, groups, configurations, etc., in different coordinates. This leads to the K-ality theory of the discipline. The original (*simple*) duality theory of rings corresponds to a certain special choice of K, of order 2.

In exploring the general K-level an interesting new class of p-ring-logies is exhibited, a generalization of the Boolian case (corresponding to $p = 2$). The *p-ality* theory of these rings is explicitly given. It is shown, in particular, that the 3-ring-logics ($p = 3$) embrace the *3-valued logic,* which consequently, as all p-rings, possesses an intrinsic *tri-ality* theory. Thus, the familiar ladder ($p = 2$): 2-valued logic (= logic of propositions) $\subset$ Boolian-rings $\longleftrightarrow$ Boolian-algebras, with encompassing (simple) duality theory, is elevated a step to ($p = 3$): 3-valued logic $\subset$ 3-rings $\longleftrightarrow$ 3-algebras, with enveloping tri-ality theory. This leads to a rich comparative study.



TECHNICAL PAPERS

Some Electrochemical Properties of Shales

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The application of glass membranes to the comparison of hydrogen ion activities in aqueous solutions suggests similar applications of other membranes for the purpose of determining the activities of other cations. In this connection recent work by Marshall and others (*2–4*) has been very significant. Initially, Marshall examined the applicability of some natural zeolites to activity determinations, but, finding these unsatisfactory, achieved greater success with membranes (0.1–0.5 mm thick) prepared from a number of hydrogen clays. In general, Marshall found that these clay membranes gave rise to potentials which, for concentrations below 0.1 molal of such monovalent cations as K^+ and Na^+, obeyed the Nernst equation.

At concentrations in excess of about 0.1 molal the potentials across the clay membranes were found by Marshall to be always less than those anticipated from the Nernst equation. He applied to his results the equation developed separately by Meyer and Sievers (*5*) and Teorell (*6*) for the potential across a membrane separating two solutions of the symmetrical valence type, viz.,

$$E = \frac{RT}{F}\left[U \ln \frac{\left(\frac{4a_2^2}{A^2}+1\right)^{\frac{1}{2}}+U}{\left(\frac{4a_1^2}{A^2}+1\right)^{\frac{1}{2}}+U} + \frac{\ln}{2} \frac{\left\{\left(\frac{4a_1^2}{A^2}+1\right)^{\frac{1}{2}}+1\right\}\left\{\left(\frac{4a_2^2}{A^2}+1\right)^{\frac{1}{2}}-1\right\}}{\left\{\left(\frac{4a_1^2}{A^2}+1\right)^{\frac{1}{2}}-1\right\}\left\{\left(\frac{4a_2^2}{A^2}+1\right)^{\frac{1}{2}}+1\right\}} \right],$$

where $U = \frac{U_c - U_A}{U_c + U_A}$, U_c, U_A are the mobilities of the cation and anion within the membrane, A = the charge on the membrane expressed as an ionic activity, and a_1 and a_2 are the molal activities of the solutions on each side of the membrane.

Marshall inferred that one possible effect of concentrated salt solutions on the membranes he had prepared was a reduction in the effective value of A, the charge upon the membrane.

The calculation of theoretical potentials across a membrane depends upon the determination of single ion activities. Single ion activities are not calculable thermodynamically, but by making certain nonthermodynamic assumptions it is probable that they can be estimated with reasonable accuracy for dilute salt solutions. These assumptions are: (a) that in dilute potassium chloride solutions the activity of K^+ is equal to Cl^-, and (b) that for dilute solutions of other chlorides the activity of the chloride ion is the same as that of the chloride ion in a solution of potassium chloride of the same ionic strength. The precise accuracy of these assumptions is unknown, but their inaccuracy does not appear to be a fundamental reason for the lack of agreement between measured and calculated potentials noted by Marshall when considering monovalent cations of concentration greater than 0.1 molal. In Table 1 the writer has used these same assumptions to compute sodium ion activities in sodium chloride solutions up to approximately 1.0 molal. The activity coefficients of sodium and potassium chloride given by Latimer (*1*) were used. No attempt has been made to compute single ion activities for sodium chloride solutions of concentrations in excess of 1.0 molal.

For the determinations reported here certain natural shales have been employed as membranes—possibly barriers would be a preferable term considering the thicknesses involved. Sodium chloride solutions are so far the only ones examined in any detail. These shales consisted of two distinct types, both obtained by rotary drilling using a diamond bit. The first type used was Conemaugh shale of Pennsylvanian age taken from depths relative to ground level ranging from 26′ to 89′. The upper portions of this shale are red; the lower, dark gray. The second type was Woodford carbonaceous shale of Devonian age from a depth, relative to ground level, of 6,808′. All specimens of both types were air-dried for about a year.

Specimens selected for test were carefully examined for cracks parallel to the bedding planes of the shale; those obviously cracked were rejected. The specimens were then mounted in a number of different ways, all of which proved satisfactory. Broadly speaking, however, the methods fell into two distinct categories. In each case the sodium chloride solutions were in contact with a cleavage surface of the shale, *i.e.* current flow from solution to solution was normal to the bedding planes. In the first method this was achieved by wax-cementing[1] a flanged male 24/40 standard taper to each face of the cylindrical shale specimen. L-shaped tubes with an i. d. of 2.5 cm and with vertical limb 15 cm high and horizontal 9 cm long, including the 24/40 female taper, were then attached to hold the sodium chloride solutions. In this method it has been found that length of shale is immaterial if the specimen is not cracked. About 3 cm is a convenient length. In the second method small chips of shale are cemented by their cleavage surfaces to the ends of glass tubes 20 mm in diameter. The sides of the shale chips are then coated with wax and also the exterior face with the exception of a hole about 5 mm in diameter. One saline solution is put into the 20-mm tube and an-

[1] The green optical pitch was No. 17, supplied by Musto, Keenan and Company, 1801 South Soto Street, Los Angeles 23, California. A suitable wax for cementing the glass to shale can be made of 100 gm of green optical pitch to which 1 cc of lubricating oil has been added.

other into a beaker in which the tube is immersed. The resistance of shale specimens so mounted varies, but the total resistance is of the order of 10,000–20,000 ohms, and satisfactory potential readings can be made with a Leeds & Northrup Type K potentiometer. A thermionic amplifier is not necessary unless the total resistance exceeds 20,000 ohms. Saturated calomel electrodes were employed as measuring electrodes, the usual precautions being taken to ensure reproducible boundary potentials between the saline solutions and the saturated potassium chloride bridges.

Results obtained using the shales to separate sodium chloride solutions of various molalities were very consistent provided the shales used were uncracked. Where appreciable cracking was present but unnoticed prior to mounting the specimens, erratic potentials were immediately observed, and the cracks themselves soon became

TABLE 1

Shale type	a_1	a_2	Calculated potential (mv)	Observed potential (mv)
Conemaugh	0.0398	0.0101	32.7	32.7
Woodford				
Conemaugh	0.395	0.0995	32.2	32.2
Woodford				
Conemaugh	0.719	0.2856	23.3	23.0
Woodford				

TABLE 2

Shale type	C_1 molal	C_2 molal	Potential from conductivity	Observed potential (mv)
Conemaugh	2.0	0.5	30.1	14.3
"	4.0	1.0	23.7	9.9
Woodford	2.0	0.5	30.1	34.2
"	4.0	1.0	23.7	28.9
"	Saturated	0.01	133.5	137.2

visible, the shales frequently shearing at the point of cracking. Attainment of equilibrium after changing the saline solutions was usually rapid unless a big change in the concentration of the solutions had been made, in which case equilibrium was only achieved after a period of days with frequent changing of the sodium chloride solutions.

In Tables 1 and 2, calculated potentials up to 1.0 molal have been derived from activities in the manner discussed above. For concentrations between 1.0 molal and saturation each ratio of the sodium ion activities in the Nernst equation has been replaced by the comparable ratio of the conductivities of the two sodium chloride solutions. This has been done because the computation of sodium ion activities at very high concentrations involves large uncertainties. The conductivity data used are not of the highest accuracy, but comparison of potentials calculated from the conductivities with observed values serve to show that the analogous shale potentials recorded in the electrical well logging of deep boreholes may be used to obtain an estimate of the conductivity of the saline fluids in petroleum reservoir rocks (7). Results are for a temperature of 20° C.

The data show that both the Conemaugh and Woodford shales appear to have marked sodium electrode properties at concentrations up to 1.0 molal, but beyond this concentration the ability of the Conemaugh to give potentials of the magnitude required by the Nernst equation is markedly inferior to that of the Woodford. This difference in behavior probably results from the varying nature of the minerals and interstitial waters in the two shales. In the case of Conemaugh shales there were no electrochemical differences between the red and gray facies examined, indicating that the state of reduction of the iron in the shales is not a primary factor.

No theory to cover the behavior of the Woodford shale is at present available, but the results show that it may be possible to produce a membrane from shales which will encompass an activity range, for sodium ions, considerably wider than that covered by any of Marshall's prepared clay electrodes. Assuming that it is justifiable to extend the application of the Meyer and Sievers and Teorell theories to cover the very high sodium chloride concentrations used in these experiments, it would appear that the thermodynamic charge, A, on the shale minerals —possibly the clay minerals in the shales—is relatively very large. Work on shale membranes is continuing.

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Carbon Dioxide, Cerebellum, Chloramines, and Convulsions

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During the past two years much light has been shed on the problem of the convulsant agent in bleached flour. Since the observation of Mellanby in December 1946 (4), that treatment of flour with nitrogen trichloride as used commercially makes such flour toxic to dogs, there has been much speculation regarding the possible effect of such a diet on man. Human experimentation is being carried on in at least three institutions, and it is too early to evaluate results obtained thus far.

We are reporting here certain observations made upon dogs fed diets containing agenized (NCl_3-treated) proteins. These observations may help to identify the toxic compound or compounds and to determine human susceptibility.

Nitrogen trichloride (NCl_3) may be prepared by the interaction of chlorine gas and ammonium chloride solution. If the pH of the reaction mixture is raised above 4.5, increasing amounts of homologues of NCl_3 are formed, namely, $NHCl_2$ (dichloramine) and NH_2Cl (monochloramine) (*1*). It is of considerable theoretical interest that these latter chloramines *do not* produce in flour a detectable convulsant compound. Only trichloramine (NCl_3) is capable of reacting with protein to produce a convulsant agent which is active after oral administration.

A similar reaction product, identified by its physiologic and electroencephalographic effects, can be produced in the wheat proteins gliadin and glutenin, the corn protein zein, and the milk proteins casein and lactalbumin (*5, 8*). When similar amounts of these proteins have reacted with equal amounts of gaseous NCl_3, the resultant toxicity appears to be proportional to the sulfur content of the original protein and not to be correlated with any other portion of the amino acid composition of said proteins (*6*). If these agenized proteins are hydrolyzed by tryptic digestion, the soluble amino acid residues retain about 50% of the convulsive toxicity of the whole protein, and they appear to be more potent by the oral than by the intravenous route. A number of laboratories are now engaged in the attempted isolation of the altered amino acid or polypeptide responsible for the convulsions.

The effects of this unknown compound are as yet best analyzed by means of the electroencephalogram. An altered EEG appears before the overt convulsion, and the seizure pattern as seen with the EEG is characteristic and significantly different from that produced by other convulsants, e.g. Metrazol or strychnine (*7*). These characteristics form the basis for this communication. First, a seizure may be provoked in a susceptible animal (dog on a bleached diet for 3 days) by the inhalation of a mixture of 20% carbon dioxide and 80% oxygen. This is somewhat surprising in view of the known "depressant" effect of CO_2 on the cerebral and cerebellar cortex. Secondly, the seizure as recorded by the electroencephalogram, whether occurring spontaneously or provoked by CO_2 inhalation, is seen to arise in the cerebellum (or at least is recorded from cerebellar leads) a few seconds before the seizure is seen in the cerebral cortex. That the cerebellum has the capacity to convulse has been appreciated although little emphasized, but that it has the capacity to "drive" the cerebral cortex into a typical tonic-clonic seizure, or that both cerebrum and cerebellum are driven almost simultaneously from a subcortical locus, would tend to establish agene convulsions (along with DDT convulsions) as a unique entity in the much explored fields of human and experimental epilepsy.

If the reaction product between NCl_3 and the protein moiety can be identified, we shall be much closer to an understanding of how it can induce convulsions. Until that time we must speculate regarding the mechanism by which certain low-molecular-weight chlorinated compounds (e.g. DDT) can produce electrical changes in the cerebellum along with cerebellar degeneration (*2, 3*), and as to why the reaction of proteins with certain chloramines and not with others can produce seizures and degeneration in the cerebellum while making the cerebral cortex more susceptible to activation by CO_2. This may well be a case where intensive investigation of what is at first sight a purely nutritional problem will yield fruitful results in the analysis of fundamental neurophysiological mechanisms.

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Construction of Glass Diaphragm Leaks for Gas Analysis With a Mass Spectrometer

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It has been shown (*1*) that the requirements of gas flow necessary to perform satisfactory gas analyses with a mass spectrometer are fulfilled essentially by molecular flow through a small hole in a thin diaphragm. For certain applications a properly designed capillary leak has also proved useful (*3*). One method of constructing a diaphragm leak has been described by Honig (*1*). We have devised a different technique which seems to be suitable for making a number of relatively uniform diaphragm leaks. Several of these have been prepared and installed in the gas inlet system of a Nier-type mass spectrometer.

The procedure used in making the diaphragm leaks is as follows: One end of a number of 5-cm lengths of 7-mm Pyrex tubing is turned in a medium oxygen flame until the tube is nearly closed and only a very fine capillary (0.02–0.04 mm in diameter) remains through the thickened end. While the end is still hot and workable, a loose-fitting carbon rod is inserted into the open end of the tube. The constricted end of the tube is gently

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[2] The authors wish to thank R. B. Bernstein for help in performing the rate of effusion experiments.

ressed between the end of the rod on the inside and a arbon block held perpendicular to the axis of the tube the outside (Fig. 1a). Excessive pressure at this oint usually distorts the normally circular cross section the capillary. Since the remaining procedure does not aterially affect the diameter of the orifice, an estimate the final orifice size can now be obtained with a micro-ope or jeweler's loupe and unsuitable closures set aside.

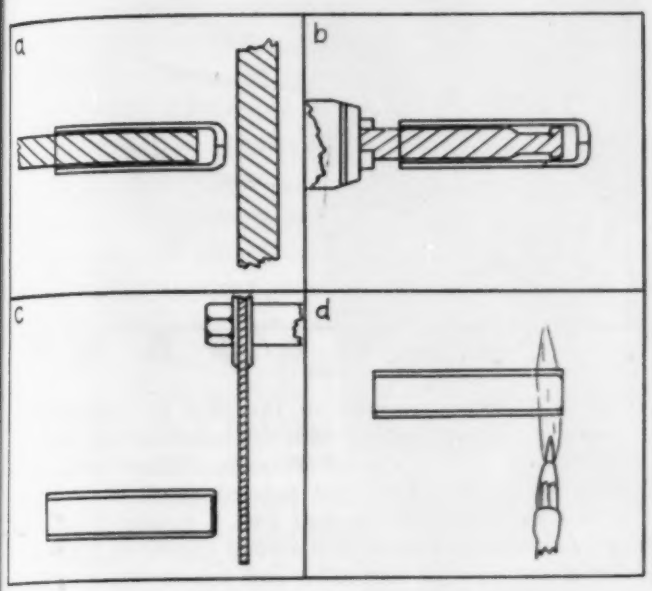

FIG. 1

ext, a length of drill rod approximately 5 mm in diam-er is mounted in a lathe or drill press and the end flat-ened with a lathe tool or grinder. Using approximately 00-mesh carborundum dust, the inner surface of the con-tricted end of the tube is ground against the end of the rill rod until any conical portion of the capillary is emoved (Fig. 1b). The inner face is now semipolished the same manner, using fine alumina (Gamal No. 2) rouge. If the shank of the grinding tool is only ightly smaller than the inside diameter of the tubing, e inner face of the diaphragm will be very nearly quare with the wall, even though the tubing is held by and while grinding. The outer face of the diaphragm now ground down to a thickness of less than 0.1 mm. metallographic polisher of a radial glass-cutting saw ith a 200-mesh carborundum disk is quite useful for is purpose (Fig. 1c). The tubing is held by hand the movable work guide with a slight pressure against e side of the disk. Care must be taken to maintain e axis of the tube perpendicular to the disk surface all times, and frequent inspection with a lens is ecessary to prevent undergrinding or destroying the iaphragm. Diaphragms set aside because of unsatis-factory closure in the first step are useful for practice rinding, and short experience makes the above pro-edure relatively easy. After rough grinding, the dia-hragm is carefully hand-lapped, using Gamal No. 2 or ouge. It was our experience that a diaphragm thick-ess of about twice the diameter of the hole would not emain plugged with polishing compound when subjected o a small hydrostatic pressure. This was used as a ough indicator for the proper amount of grinding. The semipolished diaphragm is now boiled in concentrated HCl and rinsed in distilled water and alcohol. When dry, its thickness is estimated by focusing a microscope first on its upper and then on its lower surface, using a small scratch on each surface for reference. The vertical movement of the barrel is read on the vernier scale of the microscope. If no further grinding is necessary, the diaphragm is fire-polished by directing a soft oxygen flame on the side wall of the tubing near the diaphragm end (Fig. 1d). Heat sufficient only to polish the diaphragm and adjacent side walls does not distort or enlarge the hole within the limits of measurement and results in a polished, flat diaphragm capable of withstanding a pressure differential of at least 1 atm. The diameter of the finished leak is measured microscopically.

Dimensions of one lot of 5 leaks are given in columns 2 and 3 of Table 1. Leak No. 5 was broken, and the diaphragm thickness was carefully measured microscopically and found to be quite uniform. The other diaphragms were estimated, as described above, to be about the same thickness.

TABLE 1

NITROGEN AT .05 mm, 300° K

Leak	Diameter (mm)	Thickness (mm)	Effective area, A* (cm^2)	Effusion (mg/day)
1	.044	†	5.45×10^{-6}	.42
2	.044	†	5.45 "	.42
3	.040	†	4.22 "	.33
4	.032	†	2.40 "	.19
5	.040	.088	4.22 "	.33

† Estimated to be 0.09 mm by microscopic examination.

The flow of gas through an orifice in a diaphragm of finite thickness may be calculated from the following relations, provided the pressure is sufficiently low so that the mean free path of the molecules is larger than the diameter of the hole. The total number of molecules, N, effusing from the orifice is given by the number of molecules, Z, which strike a unit area of surface per second, multiplied by the area, A, times a correction factor, P. Thus, $N = PAZ = A^* Z$. The value of Z is given by $Z = 3.537 \times 10^{22} p/(MT)^{\frac{1}{2}}$ molecules/sec, cm^2, where p is the pressure in millimeters of mercury, M is the molecular weight of the gas, and T, the absolute temperature. Loeb (*2*) has tabulated values of P as a function of the ratio of the thickness of the diaphragm, L, and the radius of the hole, R. The calculated effective area, A*, of each orifice is given in column 4, Table 1. With the first four leaks in parallel, the total effective area is calculated to be 1.75×10^{-5} cm^2. The uncertainty is estimated to be ±20%, principally because of uncertainty in the thickness of the diaphragm. The mass of nitrogen that would effuse through the four orifices from a reservoir at a pressure of 0.05 mm and a temperature of 27° C is 1.36 mg/day. For a 10-liter reservoir this is equivalent to a pressure drop of approximately 6%/hr.

The four leaks in parallel were sealed into the inlet system of a mass spectrometer. Several tests were made in which the rate of pressure change in a 10-liter reservoir behind the leaks was periodically measured, both by means of a McLeod gage and by detection of the appropriate ion with the mass spectrometer. The results indicated an effective area of 2.1×10^{-5} cm for the four leaks in parallel and a nitrogen flow of about 1.6 mg/day, agreeing with the calculated values within the estimated uncertainty.

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A New Influence on Chemically Induced Sarcomata[1]

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Many influences have been established as effecting the induction of sarcomata by chemical means. These influences may be classified into two groups, as follows: (1) the environmental and (2) the genetic. Under the environmental influences may be listed the specific carcinogenic compound, the amount used or dosage, the vehicle or solvent, the mode of introduction, the age of the experimental animal, and the species or subline of experimental animal employed. The genetic influence has always been inherited as a dominant multiple factor complex, although, in many cases, the susceptibility of the F_1 individual to the chemically induced tumor approaches the susceptibility of the dominant parent, but does not do so completely.

Examples of linkage between genes for susceptibility to induced neoplasms and the well-known color or morphological genes of mice have been demonstrated primarily by the work of Heston and of Strong. In an attempt to investigate further the nature of the genetic influence on the induction of tumors by methylcholanthrene, the following experiment was performed:

Mice of the NHO strain showing an intermediate degree of susceptibility to the subcutaneous development of sarcoma at the site of the injection of methylcholanthrene were outcrossed to mice of the C57 subline which showed a high degree of susceptibility to the same induced tumor. The outcross was made in both directions. Two hundred fifty-four F_1's were obtained. At 60 days of age the F_1 mice were injected with 1 mg of methylcholanthrene dissolved in 0.1 cc of sesame oil. The mice were periodically examined for tumors. Data obtained on the rate of appearance of tumors induced by methylcholanthrene are plotted in Fig. 1.

The mice were divided into three groups according to the litter in which they were born. Mice born in the first and second litters comprise group 1; mice born in the third and fourth litters of the same breeding parents were put into group 2; and mice born in the fifth and sixth litters of the same parents were classified as group 3. The three groups were approximately of the same size (93, 80, and 81 mice, respectively). An examination of Fig. 1 discloses the fact that mice of the three groups develop sarcomata at the site of the injection of methylcholanthrene at significantly different rates. The rate for the appearance of tumors was slowest in group 1, intermediate in group 2, and highest in group 3.

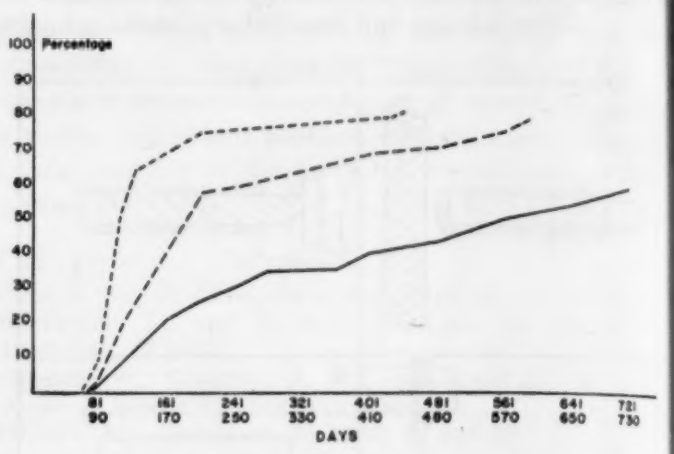

FIG. 1. Data obtained on the rate at which fibrosarcomata appear at the site of injection of methylcholanthrene in a series of F_1 mice. Time in days is given on the base line, the percentage of mice showing tumors along the vertical line. Group 1 consists of mice belonging to first and second litters (solid line); group 2, of mice of the third and fourth litters (long-dash line); and group 3, of mice from the fifth and sixth litters of the same breeding parents (short-dash line).

All mice of the F_1 generation produced by an outcross of mice of two inbred strains are theoretically genetically alike. The difference of susceptibility to induced tumors obtained in this experiment is consequently not a genetic one. It is obvious that something which is increasing or decreasing in the mother's body is being handed down to her offspring. It is also possible that this principle varies in the father's contribution to progeny, although the evidence for this concept has so far not been indicated. This transmitted principle sensitizes or changes the progeny's susceptibility to a subsequent injection of methylcholanthrene, influencing the rate at which the offspring develop sarcoma in the presence of a given amount of methylcholanthrene. There are possible at least three modes of transmission for this principle. It may be (1) by cytoplasmic inheritance, (2) by transplacental transmission, or (3) through the mother's milk. These three were the modes of transmission regarded as possible for the transmission of susceptibility for spontaneous adenocarcinoma of the mammary gland in mice by the group at the Jackson Memorial Laboratory. In the spontaneous adenocarcinoma work it was subsequently conclusively demonstrated that the principle was transmitted through the mother's milk. This principle producing adenocarcinoma of the mammary gland is now sometimes referred to as the virus of Bittner.

[1] This experiment has been made possible by grants from The Jane Coffin Childs Memorial Fund for Medical Research and The Anna Fuller Fund.

In the present investigation it is extremely doubtful whether this new principle that influences chemically induced sarcomata is transmitted through the mother's milk, since there is ample evidence that foster nursing does not modify susceptibility or influence the rate at which the induced tumor appears following the injection of the carcinogen (unpublished data of author).

The present investigation is of significance, since it demonstrates that a new principle, presumably of a biochemical nature, has influenced the production of a malignant tumor. This agent varies in amount or potency with advancing age and is transmitted to the next generation. Perhaps when it is identified, other phases of the cancer problem, such as prevention and spontaneous regression, may be elucidated. Susceptibility to cancer is, of course, only the obverse of resistance to cancer. The present evidence indicates equally clearly the existence of a new *resistant* mechanism that is capable of changing the rate at which an offspring of a given female develops sarcoma in the presence of methylcholanthrene, that it is highest in young breeding females and diminishes in effectiveness with advancing age. It is in the young animal that this resistant mechanism for the control of some characteristics of cancer must be sought.

By the use of F_1 individuals that will grow the normal tissues of both ancestral stocks, the elucidation of this mechanism for resistance to cancer in young animals will be considerably aided.

Antibacterial Action of the Blood of the Large Milkweed Bug[1]

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The blood of the large milkweed bug, *Oncopeltus fasciatus*, contains an antibacterial agent active *in vitro* against *Staphylococcus aureus* and one strain of *Bacillus subtilis*. The active principle is water soluble, stable to boiling for 30 min but destroyed by autoclaving, and active at a dilution of at least 1 part in 10,000.

The large milkweed bug, a well-known laboratory insect, may be kept in culture throughout the year, with little care and expense, feeding on milkweed seeds and water (7). It is prolific and requires only about 3 weeks for development from egg to adult.

In our experiments two methods were used for obtaining blood from the bugs. For samples of pure blood, the legs and antennae were cut and the exuding droplets taken up in a pipette and diluted with physiological (0.85%) saline solution. This is a time-consuming procedure. For routine testing, therefore, the bugs were slit along the thorax and abdomen and the blood extracted by shaking in saline solution. This extract was filtered before use. When distilled water was substituted for saline solution, the extract was devoid of activity.

There are two possible objections to obtaining blood by the rapid extraction method: first, the solution thus obtained is heavily contaminated with bacteria; second, there is the possibility of contamination with feces of the bugs. With respect to the first objection, our observations lead us to believe that the bacteria thus introduced contribute nothing to the antibacterial action of the extract, since the extract may be put through a bacteriological filter or may be boiled up to 30 min without losing its activity. With respect to the second objection, it may be noted that tests with blood obtained without fecal contamination gave exactly the same results as those utilizing the extract. Further, if adult bugs were used, they either defecated on being slit, thus enabling removal of the feces, or usually they did not defecate at all. With nymphal bugs, which often defecated in the solution, fecal contamination was a factor, reducing the antibacterial activity. For this reason, adult bugs were used for all the experiments except those designed specifically to test the blood of nymphal bugs.

TABLE 1

Preparation	Diameter of ring of growth inhibition (mm)
1 part blood : 1 part saline	22
1 part blood : 49 parts saline	15
Filtered extract (1 bug/ml)	18–22
Same extract ether extracted, boiled, and refiltered	18–22
1 unit of penicillin/ml of dilute phosphate buffer	19–22

Antibacterial action was tested by the cylinder-plate method used in penicillin assay, using 10 ml of standard nutrient agar seeded with about 0.1 ml of a 24-hr broth culture of the test organism and incubating at 37° C for 16–18 hrs. When penicillin assay agar enriched with glucose and yeast extract was used, the zones of inhibition were smaller and not clear cut.

With *Staph. aureus* as test organism, the results presented in Table 1 were obtained. These show that, by the extraction method, the antibacterial activity from a single bug is the equivalent of above 1 Oxford Unit of penicillin. The actual content of the bug is undoubtedly greater, for this method does not extract all the blood. The blood of last instar nymphal bugs has antibacterial action like that of the adults.

The extract was active against *Staph. aureus* (F & D 209) and, to a lesser degree, *B. subtilis* (F & D 558-S),

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[2] We wish to thank Dr. Lyle Hagmann, of Rutgers University, for supplying us with bugs for some of the experiments and Prof. R. W. Stone, of this College, for his helpful interest throughout the work.

and was inactive against *B. subtilis* (ATCC 6633), *Escherichia coli, Salmonella typhosa, Pseudomonas pyocyanea, Alcaligenes fecalis, Corynebacterium diphtheriae mitis, Klebsiella pneumoniae, Mycobacterium phlei,* and *Streptococcus durans.*

Further experiments on properties of the active principle in the blood have so far yielded the following information: It is water soluble and not extractable from an aqueous solution with ether or butanol. It is destroyed slowly in the filtered saline extract on standing at room temperature, most of the activity being lost within 6 hrs. This destruction is hastened by heating, most of the activity being lost after boiling for over 30 min or autoclaving at 20 lbs for 10 min. If the lipids are removed from the saline extract by ether extraction before boiling, however, the solution is more stable. The active agent is not a protein which is precipitated by boiling, for removal of the precipitated proteins after boiling the saline extract does not reduce the activity. Filtration of the extract through ordinary or bacteriological filters does not impair the activity.

Apparently the active agent is synthesized in the body of the bug and not found as such in the milkweed seeds, for hot and cold saline extracts of the seeds are inactive. Further, a diet of milkweed apparently is not sufficient to cause the production of this agent, for solutions of the blood of three other species of insects which feed on milkweed exclusively—the red milkweed beetle, *Tetraopes tetrophthalmus,* the harlequin milkweed caterpillar, *Euchaetias egle,* and larvae of the monarch butterfly, *Danaüs plexippus*—are inactive.

Antibacterial substances from the blood of insects have been reported previously, but these have not been so directly extracted or so similar to familiar antibiotics in action. Glaser (*1*) found the blood of a grasshopper destructive to bacteria pathogenic for grasshoppers, and Olivier (*3*) found neutralized aqueous NaOH washings of an acetone extract of macerated wax moth larvae, *Galleria mellonella,* active against tubercle bacilli.

The feces of blowfly maggots have also been found (*2, 4, 5, 6*) to destroy, even after autoclaving, such important pathogens as *Clostridium welchii, Salmonella typhosa, Brucella abortus,* and hemolytic streptococci. We have repeated the experiments of Simmons (*5, 6*) with feces from the larvae of the black blowfly, *Phormia regina,* using both his method and the cylinder-plate method of testing for antibacterial action against *Staph. aureus.* Our results have been uniformly negative. The observation of Gwatkin and Fallis (*2*) that antibacterial activity of the feces of maggots decreases regularly with rearing in captivity offers a possible explanation for the discrepancy in results. The flies we used have been reared for many years in the laboratory, for a time under sterile conditions. These facts suggest that the bacterial flora of the digestive tract of the maggots or of the larval food (*4*) may be involved in the production of the antibacterial agent.

Certainly, all of the results suggest that insects, famous for their hardiness and rapidity of reproduction, may be, directly or indirectly, sources of new antibacterial agents of possible practical value.

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Protection of Mice Against an Encephalitis Virus by Means of Organic-Solvent Extracts of Brain Tissue

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It has been shown (*1*) that a material extracted from the sera of normally-appearing animals by means of organic solvents inactivated certain neurotropic viruses *in vitro,* and a substance having similar properties, although to a lesser degree, could be obtained from brain tissue. Since these materials were without pronounced toxic effect in mice, attempts were made to uncover any possible action on the viruses *in vivo.* As will be noted, tests with Russian Far East (spring-summer, tick-borne) encephalitis virus revealed protection in mice against small amounts of virus by means of such extracts of brain tissue.

Brain extracts. Brain tissue from either apparently normal mice or sheep or from mice infected with viruses unrelated to the Russian virus was extracted in succession with acetone and ethyl ether or with a mixture of chloroform and methyl alcohol. The extracts were filtered through filter paper, evaporated to dryness, resuspended in saline solution, and dialyzed against 5% of 0.15M phosphate buffer in saline solution, pH 7. The final volume of the suspension was four times the weight of the brain tissue extracted. The preparations were stored at 4° C, and their protective effect was evident even after heating at 62° C for 1 hr on 3 successive days or at 95° C for 1 hr once. Before injection into mice, these materials were centrifuged at 1,500 rpm for 15 min and the supernatant used. The treatment consisted of either two injections of 0.5 cc of this material given intravenously 2 and 24 hrs after or one 24 hrs before the intraperitoneal challenge inoculation of virus. Following injection of the extracts, the mice exhibited at times a mild reaction, with ruffled fur, decreased activity, and diarrhea; their appearance was normal within 24 hrs. Ten of 816 mice died, 7 of the 10 succumbing after receiving one preparation.

It soon became apparent that if this material were used within 10 or 12 days after preparation, it possessed

protective effect. If, however, the extracts were kept the refrigerator for longer than 4 weeks—100 days the longest period thus far tested—a definite and sig-cant effect was noted.

Preparation of the extracts under strict aseptic con-ions was not practical; it was found that in almost all es a bacterial contaminant was present which appears be in all instances of the *Alcaligenes* genus. The pos-le participation of this contaminant in the protective ct observed is being investigated. It has been been nd, nevertheless, that when the extracts shortly after paration are sterilized by heating at 62° C for 1 hr

Table 1 describes some of the tests. The mice were uniform in age, weight, and sex in each test. The controls were inoculated with dilutions ranging from 10^{-7} to 10^{-11}; the treated mice, in general, with dilutions of 10^{-7} to 10^{-9}. The LD_{50} is calculated on the assumption that when the 10^{-7} dilution of virus was not inoculated, all treated mice if given this dilution, would have died; also, had the treated animals received the 10^{-10} dilution, all would have survived; the latter is probable, since the untreated had with this dilution a death rate of only about 10%. It will be noted that the preparation employed in Experiment 1 failed to protect when it was

TABLE 1

MICE INFECTED INTRAPERITONEALLY WITH RUSSIAN FAR EAST VIRUS AND TREATED INTRAVENOUSLY WITH MATERIAL EXTRACTED FROM MOUSE OR SHEEP BRAIN WITH ORGANIC SOLVENTS

p.	Brain extract in refrigerator (days)	Treatment and source of extract	When treated in relation to virus inj.	Dilution of virus −7	−8	−9	−10	−11	LD_{50}	Difference*
		None, controls		12/12†	11/12	7/12	1/12	0/12	9.14	
	2	2 inj. Prep. A, (mouse)	2 and 24 hrs after		12/12	5/12			8.86	− .28
		None, controls		12/12	11/12	6/12	0/12	0/12	8.93	
	29	2 inj. Prep. A, (mouse)	2 and 24 hrs after		2/12	2/12			7.70	−1.23
		None, controls		18/20	18/20	16/20	1/12	0/12	9.28	
	100	1 inj. Prep. B, (mouse)	24 hrs before	17/18	7/20	1/20			7.78	−1.50
		None, controls		14/15	15/15	8/15	1/10		9.07	
	28	1 inj. Prep. C, (sheep)	24 hrs before	9/15	2/15	0/15			7.27	−1.80

* −.80 log or less is significant based on $2 \times \sqrt{2} \times$ standard deviation.
† 12 mice died of 12 inoculated.

3 successive days, they are as effective as the non-rilized ones under similar conditions. In all instances rthiolate in final concentration of 1:10,000 is added each extract 2 days before it is used in a test.

Virus. Russian Far East encephalitis virus is the only e thus far used in these tests. It was assumed at the tset that an intracerebral challenge of resistance might a test too severe to detect small protective effects; r this reason a neurotropic virus was chosen which could fect adult mice after peripheral injection, even in high utions. Decimal dilutions of virus were prepared, and cc was given intraperitoneally to each mouse. In titrations (including the 4 shown in Table 1) using m 8 to 24 mice/dilution, the control mice gave an erage LD_{50} titer of $10^{-8.91}$, with a variance of 0.0788 d a standard deviation of 0.2808. If, following Lauf-r and Miller, and Horsfall and Curnen (*2*), a difference $2 \times \sqrt{2} \times$ standard deviation is considered as significant, y preparation which showed a difference of titer of rus in controls and in treated mice equal to or greater an 0.80 log unit should be regarded as significant. In experiments thus far carried out, the differences of er of virus in controls and in treated mice were as llows: −0.88, −0.93, −0.97, −1.23, −1.28, −1.33, −1.44, .46, −1.50, and −1.80 log.

kept in the refrigerator for only 2 days, but this preparation as well as the others, when "aged" from 4 weeks to 100 days, yielded a degree of protection that was, according to the standard here used, significant. It can further be shown that if large enough numbers of mice are used per dilution, the results are unlikely to occur by chance (Experiment 2); thus, for the 10^{-8} dilution, $p = 0.0004$, and for the 10^{-9}, $p = 0.000001$. No protection was detected when treatment was delayed 48 hrs after infection.

In conclusion, mice infected with Russian Far East encephalitis virus by intraperitoneal route can be protected significantly with a material extracted by means of organic solvents from mouse or sheep brain tissue. The brain extract, when aged 4 weeks or longer in the refrigerator, was given intravenously either 24 hrs before or 2 and 24 hrs after injection of the virus. In the tests reported the difference in titer of virus between the treated mice and controls ranged from −0.88 to −1.80 log, values which are significant.

References

1. CASALS, J., and OLITSKY, P. K. *Science*, 1947, **106**, 267.
2. LAUFFER, M. A., and MILLER, C. L. *J. exp. Med.*, 1944, **79**, 197; HORSFALL, F. L., JR., and CURNEN, E. C. *J. exp. Med.*, 1946, **83**, 25.

Comments and Communications

Allotment of Funds for Research

In the current discussion as to regional *vs.* national distribution of research funds (Clarence A. Mills. *Science*, February 6, pp. 127–130; October 22, p. 438; and Thomas B. Turner. *Science*, April 16, p. 391) there seems to be some confusion as to the purpose of such funds. If funds are raised to aid in the solution of some scientific problem (as *rescarch* implies), then I see no relevance of this to regional distribution. If it happens that the Northeast is now better equipped to produce desired results, that is where the money should go. If some one problem can best be handled elsewhere, then it should be handled there. Research results (the aim in view) are valid, regardless of where or by whom produced.

If, on the other hand, the purpose is an over-all national development, as Dr. Mills implies, then the funds are given the wrong name. They are not *research* funds unless they are to be used for research.

Probably we need two funds, one for each of these worthy objectives, but these objectives should not be confused as they apparently now have become. As an impartial observer from a region not well represented in the present allotment of these funds, I cannot see that Dr. Mills has proved his implication that most funds have gone to the East because eastern scientists on the allotting boards are biased for their own institutions and regions.

ARTHUR N. BRAGG

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A Simple Method of High-Power Tissue Stimulation

For those physiologists faced with the necessity of stimulating nerves or other highly sensitive tissues, Dr. Schmitt's ingenious R.F. circuit outlined in an earlier issue of *Science* (April 23, p. 432) is doubtless a most satisfactory solution. Unfortunately, those who require relatively high-power stimulation are unable to use his device because of the inherent power limitations of the circuit and the associated restriction to relatively high-impedance leads.

A method for high-power stimulation is described here which permits ordinary stimulators to be operated with enough conductive and capacitive isolation from ground to enable relative freedom of sensitive recorders from shock artifact. This method is very simple and does not require the construction of any special electronic circuits.

A high-powered stimulator, of the type usually operated off house current (110 v a-c), is plugged into a 12-v d-c–115-v a-c inverter instead of the normal wall outlet. This inverter is in turn connected to two automobile-type storage batteries arranged in series. The stimula inverter, and storage batteries are placed close toge on a nonmetallic surface at least several feet from nearest sizable metal object. Fig. 1 indicates the

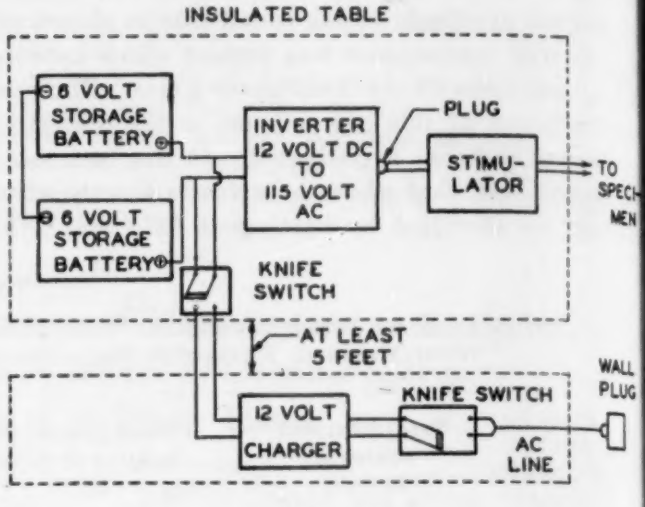

FIG. 1

nections made between these and the charger requi for the batteries. Two charger switches are necesary insure satisfactory electrical isolation of the apparat

When the stimulator is to be operated, the charg switches are opened.

It has been found necessary to ground the specimen one point in order to eliminate a-c interference from records.

The stimulator, inverter, batteries, and charger are available commercially.

RICHARD McF

Department of Electrical Engineering, Syracuse University

Cenogonal—A New Crystallographic Term

In a consideration of the various types of zones (A. Rogers. *Introduction to the study of minerals*, 3rd e 1937, pp. 33–35) encountered in geometrical crystallo raphy, I have felt the need of a word to designate angl that are common to two or more crystal species.[1] T angles to which I refer are angles such as 26°34′ (arc c 2),[2] 18°26′ (arc cot 3), 14°2′ (arc cot 4), and in gener arc cot n, where n is rational; also such angles as 16°6 (arc cot $2\sqrt{3}$), 10°53½′ (arc cot $3\sqrt{3}$), and in general a cot $n\sqrt{3}$, where n is rational.

At first I considered expanding the term "crystall metric," used by Nevil Story-Maskelyne (*Chem. New* 1875, **31**, 101) and elaborated upon in his textbook (*Cry tallography, a treatise on the morphology of crysta* 1895, p. 77). By crystallometric angles, Story-Maskely meant the angles that planes of symmetry make wi each other, which are 30°, 45°, 60°, and 90°. W. Lewis (*A treatise on crystallography*, 1899, p. 21) al used crystallometric in the same sense, but it is a ve rare word in crystallographic literature.

[1] "Crystal species" is used to include crystals produced the laboratory as well as mineral crystals.

[2] The expression arc cot is preferred to the symbol cot

enerally speaking, redefinition of terms is unwise in opinion. I have therefore cast about for a suitable d. The Greek κοινός (common) comes to mind, since primary meaning is "shared in common." The les mentioned above are common to various crystal cies.

My colleague, Raymond Harriman, of the Classics De- tment, called my attention to the fact that in using expression "cenogonal angle" one is repeating the of angle, since γωνία is the Greek word for angle, in spite of this, the term seems the best one available. Cenogonal angles include the angles in the tetragonal e [001] of the tetragonal system as well as the angles the hexagonal zone [00–1][3] of the hexagonal system l all the angles between the faces of crystals in any of zones of the isometric system. In Dana's *System of neralogy* (6th ed., 1892) a fairly complete list of these gles may be found (pp. xx–xxvi). It should be empha- ed that cenogonal angles are predictable; that is, they y be calculated in advance of any knowledge of the ial ratio. The use of a special term such as "cen- nal" emphasizes the importance of the predictable gles.

I wish to acknowledge my indebtedness to my col- gues, Harry Caplin, J. D. H. Donnay, H. F. Fränkel, A. Francis, R. D. Harriman, Philip Harsh, Stanley rold, R. F. Jones, Louis H. Kanter, Lionel Pearson, C. Peer, G. Polya, and Julian Smith, for the oppor- nity of discussing various terms.

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nford University

iticism of a Definition of pH

The following definition has appeared in a long series editions of the Chemical Rubber Publishing Company's *ndbook of chemistry and physics*: "Hydrogen ion con- ntration or pH value is the logarithm of the reciprocal the gram ionic hydrogen equivalents per liter; i.e., $H = \log \frac{1}{(H^+)}$ per liter." Thus, it would appear that H is the negative logarithm of pH, like the man in the pular song who was his own grandfather. Several nes I have called the attention of the editor of the ndbook to this error, but so far without result.

The relation, $pH = -\log (H^+)$, in which (H^+) is the drogen ion concentration, as given by Sorensen in 1909, represented the prevailing ideas sufficiently well at that time. Since then the meaning and the calibration of the pH scale have received both theoretical and experimental attention with the result that quite a number of papers have accumulated on the subject (Cohn, Heyroth, and Menkin. *J. Amer. chem. Soc.*, 1928, **50**, 696; Guggenheim and Schlinder. *J. phys. Chem.*, 1934, **38**, 533; Hitchcock and Taylor. *J. Amer. chem. Soc.*, 1937, **59**, 1812; MacInnes, Belcher, and Shedlovsky. *J. Amer. chem. Soc.*, 1938, **60**, 1094; R. G. Bates. *Chem. Rev.*, 1948, **42**, 1; etc.). In possibly all but one case in a thousand it is not necessary to consider the meaning of pH in terms of solution theory at all, but only to accept the numbers as a practical scale of acidity and alkalinity.

From an operational point of view, pH values are the result of measurements of the potentials, E, of galvanic cells of the type: (Pt)H_2; solution X : sat'd KCl; reference electrode with the aid of the equation,

$$pH = \frac{E - E_0}{2.306\,RT/F}.$$

Here "solution X" is the fluid whose pH is desired, E_0 is a constant depending upon the nature of the reference electrode and the temperature, and R, T, and F are the gas constant, the absolute temperature, and the faraday, respectively. For most purposes, therefore, it is only necessary to agree on values of the constant E_0. However, studies have been made leading to closely agreeing values of this constant at a series of temperatures such that, if the pH measurements are interpreted in terms of thermodynamic ionization constants, no serious errors will be made.

According to present theories of electrolytes, there is no simple relation between the hydrogen ion concentration and the pH value of a solution. The relation $pH = -\log (H^+)$ is an approximation only, and using it as a definition may lead to serious errors. The expression $pH = -\log a_{H^+}$, in which a_{H^+} is the activity of the hydrogen ion, is also open to objection, since the activity of a single ion species is not an operational concept.

It is the author's rather forlorn hope that compilers of handbooks and authors of textbooks will someday indicate that the expression $pH = -\log (H^+)$ is *not* a definition and that it may be, in some cases, only a very rough approximation.

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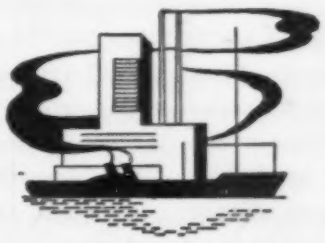
[3] In zones of the hexagonal system the writer prefers the ethod of omitting the third index.



Book Reviews

Heat conduct'on: with engineering and geological applications. Leonard R. Ingersoll, Otto J. Zobel, and Alfred C. Ingersoll. New York-London: McGraw-Hill, 1948. Pp. xii + 278. $4.00.

This text, one of the International Series in Pure and Applied Physics published by McGraw-Hill, is much more than a careful revision of the older text by the two senior authors. The first book appeared 35 years ago and is a familiar classic in this field.

Something of the difference between this text and the older one is indicated by the titles. The earlier title is *Mathematical theory of heat conduction.* The new text retains much of the format of the other text, and in this sense it is a revision. Symbols, however, have been revised, and a table on nomenclature in the Introduction will be very useful to anyone consulting the book. The applications are thoroughly illustrated in the text. General and particular solutions are worked out, and lists of problems and an excellent bibliography give the interested individual a fine opportunity to interpret and solve his own needs.

As the authors point out, the use of Fourier series to attack the problems arising when heat flows is not original with them. It should be noted, however, that there are few sources in the literature where the details of this problem of flow are so clearly introduced. Indeed, the methods described and illustrated so carefully in this book can be applied in many problems arising in connection with the study of anything which flows under the influence of the gradient of some potential function such as temperature.

Thus, the beginner in theoretical physics could be appropriately introduced to a method of attack to many problems through the use of *Heat conduction* as a text. The engineer who needs a means of interpreting some of the myriad curves that he draws will find constructive ideas here. And the person who wants a neat solution of specific problems in heat exchange will find here a surprisingly large number of practical instances for so modest a text. Bibliography and appropriate mathematical tables found at the back of the book will also prove explicitly useful.

Reading the text left the writer with a feeling of need for an understanding of what happens at boundaries in heat flow problems, for this depends so intimately and often obscurely on radiation and convection exchanges there. In fact, boundary problems and phenomena which develop due to grain size and nonhomogeneity of media often make it hard to define exactly what flows. Then, too, the concept of heat involves temperature, and temperature is defined only under equilibrium conditions which, strictly speaking, do not exist when heat is conducted. Heat exchanges across boundaries where sharp discontinuities in temperature exist are very important in most practical problems. No one should feel, however, that all heat flow problems can be solved in any one book. The authors make no such pretense, but are very careful to state the conditions they are treating.

Additions appearing in this book have definitely improved its range of usefulness. The accuracy of treatment is unquestioned, and the authors are to be congratulated in bringing so important a classical tool of physics up to date so neatly.

R. F. P[illegible]

University of Illinois

Applied physics: electronics, optics, metallurgy. (Scie[illegible] in World War II, OSRD.) C. G. Suits, George R. Ha[illegible] son, and Louis Jordan. (Eds.) Boston: Atlan[illegible] Little, Brown, 1948. Pp. xiii + 456. (Illustrate[illegible] $6.00.

This book relates the work of three divisions of [illegible] National Defense Research Committee—namely, e[illegible] tronics (mostly countermeasures for radar), optics, [illegible] metallurgy—these being embodied in what, in the f[illegible] organization, were Divisions 13, 15, 16, 17, and 18 of [illegible] National Defense Research Organization.

The question which arises in one's mind when he s[illegible] a book covering as large a field of activity as is enc[illegible] passed by several divisions of NDRC is: "Just why [illegible] the book written, anyway?" A brief perusal of t[illegible] book shows the purpose was not for entertainment, [illegible] can it be considered that the book was written just[illegible] honor individuals and enable them to see their names[illegible] print. Undoubtedly, such a book has valuable histori[illegible] aspects not only in recording the accomplishments of s[illegible] a group but also in recording the failures so that th[illegible] who might have to go through this the next time w[illegible] profit. Unfortunately, many of the incidents related [illegible] this purpose are not of general interest and cannot app[illegible] to a wide variety or a large number of readers.

No writer could take so many characters and so ma[illegible] events and weave them into a continuous thread of [illegible] story. This book recounts the exploits of hundreds [illegible] people working on scores of unconnected projects. The[illegible] fore, it is expected that the book itself is a disconnec[illegible] story. This is very apparent in the section on Opti[illegible] but no matter how unsatisfactory the result, it is d[illegible] ficult for the reviewer to see how it could have been do[illegible] differently. This limitation is not as real in the secti[illegible] on Countermeasures, but here it is clearly evident that t[illegible] section was written by a number of individuals wh[illegible] final efforts were not properly coordinated. It is d[illegible] concerting for a reader to go through the life and develo[illegible] ment of the countermeasure "Window" so many tim[illegible] One does this first on page 24, where he learns, in part[illegible] ular, the story of the British machines for making th[illegible] device. Further on (p. 43) he is told almost the sam[illegible] story again in almost the same words. Actually, "W[illegible]

dow'' is mentioned 33 times in the index of the book, and it seems that almost 33 stories of it are given.

Another fault of the book is that too often a device is mentioned by name, and it is assumed that the reader has some idea of the usefulness and method of operation of the device. This assumption is proper if the audience is limited to those familiar with the field. Applied physicists and electrical engineers engaged in the use of ultrahigh frequencies recognize the terms ''magnetron,'' ''lighthouse tube,'' and so on. But it is doubtful if a worker in the field of optics knows what these devices are, and certainly the layman or casual reader is immediately beyond his depth.

Another unfortunate, but perhaps necessary, fault of the book is that so many names are given. Such detail is lost on any casual or even studious reader who has no personal ties to those named.

In spite of all this, one finds the volume interesting reading if he has some knowledge of the field or if he has sat on the sidelines while the work was being done. To those who expect to continue in any one of these lines of work or to be engaged in it in another war, sections of the book will prove to be valuable. Few will read it from beginning to end.

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Scientific Book Register

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PIRENNE, M. H. *Vision and the eye.* London: Pilot Press, 1948. Pp. xx + 187. (Illustrated.) 12/6.

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TRAQUAIR, H. M. *Clinical ophthalmology: for general practitioners and students.* St. Louis, Mo.: C. V. Mosby, 1948. Pp. xii + 264. (Illustrated.) $9.00.

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NEWS and Notes

John W. Bennett, assistant professor of sociology and anthropology at Ohio State University, has been appointed associate chief of the Division of Civil Information with the Supreme Commander for the Allied Powers in Japan. Dr. Bennett has been granted a one-year leave by the University and will go to Tokyo next February. There he will plan and conduct various types of social and sociopsychological research ranging from public opinion and attitude surveys to community studies.

Jerry W. Carter, Jr., on leave of absence since January 1948 as director of the Wichita Guidance Center, has resigned to continue as chief clinical psychologist, Community Services Branch, Division of Mental Hygiene, U. S. Public Health Service, in Washington, D. C.

Allen J. Sprow has been appointed assistant editor of *Psychological Abstracts* and instructor in psychology at the Galesburg Division of the University of Illinois.

Kenneth S. Pitzer, professor of chemistry at the University of California, Berkeley, has just been appointed director of the Division of Research, Atomic Energy Commission, succeeding **James B. Fisk,** who resigned August 27 to take up his duties as professor of applied physics at Harvard University. Dr. Pitzer, who will be on leave from the University while serving with the AEC, will assume his new position on January 1. As director of research, he will supervise the Commission's research program in the physical sciences as well as the administration of the isotope production and distribution program.

A. Orville Dahl, of the Botany Department, University of Minnesota, has been appointed professor and chairman of the Department.

Howard B. Adelmann, professor of histology and embryology and chairman of the Department of Zoology, Cornell University, has been elected a member of the Institute International d'Embryologie. The Institute, formed to promote the collection of embryological materials in various centers throughout the world, limits its membership to 75 prominent embryologists.

C. Donald Van Houweling, former director of veterinary medical relations for the Illinois Agricultural Association, has joined the executive staff of the American Veterinary Medical Association, Chicago. In his new position, Dr. Van Houweling will deal primarily with problems of mutual interest to livestock producers, agricultural groups, and veterinarians.

W. W. Rankin, of the Mathematics Department, Duke University, and director and founder of the annual Mathematics Institute at Duke, has been appointed chairman of a committee to organize similar institutes in other sections of the Nation. Prof. Rankin's appointment was made by E. H. Hildebrandt, president of the National Council of Teachers of Mathematics, in recognition of his work at Duke.

Warfield Garson, formerly visiting associate research specialist in the Department of Microbiology, New Jersey Agricultural Experiment Station, has been placed in charge of antibiotic research at the V. D. Research Laboratory, U. S. Marine Hospital, Staten Island, New York.

Grants and Awards

The American Chemical Society has announced the establishment of two new $1,000 prizes for achievements in petroleum chemistry and in the field of flavor and perfume oils. The petroleum prize, founded by the Precision Scientific Company of Chicago, may be given to a U. S. or Canadian citizen who shall not have passed his 40th birthday on April 30 of the year in which the award is to be presented. The essential oil prize, established by Fritzsche Brothers, Inc., of New York, carries no limits with respect to age or nationality. Nominations for these prizes should be submitted by January 1, 1949, to Alden H. Emery, Executive Secretary of the ACS, 1155 16th Street, N.W., Washington 6, D. C.

Beta Sigma Phi, an international educational and cultural organization of young women, has granted $14,40[illegible] to the University of Colorado for support of the research project being carried on by Edward D. Crabb, professor of biology, and Margaret A. Kelsall, research associate in biology. Their research concerns the relationships of lymphocytes in the development and spread of sarcoma in the Syrian hamster.

Grants amounting to $185,600 were made by the Board of Trustees of the Nutrition Foundation, Inc., at a meeting held recently in New York City. The sum of $1,810,730 has now been awarded by the Foundation to 62 universities and medical centers in the United States and Canada. Charles Glen King, scientific director of the Foundation, pointed out at the luncheon meeting that basic research made possible by the Foundation has produced gains in public health, the most notable advances being made with respect to hypertension, anemias, tooth decay, and protein deficiency.

The Rumford Fund of the American Academy of Arts and Sciences is offering small grants for researches in the general fields of heat and light. In the past the Committee has assisted work in physics, chemistry, biology, astronomy, and meteorology through provision of equipment, expendable materials, technical assistance, and traveling expenses on a modest scale. Inquiries should be addressed either to the Committee at the Academy headquarters, 28 Newbury Street, Boston, Massachusetts, or to the chairman of the Committee, Dr. Harlow Shapley, Harvard College Observatory, Cambridge 38, Massachusetts.

Albert Milzer, director of the Department of Bacteriology and Virology, Michael Reese Hospital, Chicago, has been awarded a grant of $1,000 by the Committee on Scientific Research of the American Medical Association to conduct a survey of virus and rickettsial infections in the Chicago area.

Colleges and Universities

The Department of Physiology and Biophysics, School of Medicine, University of Washington, has been awarded a two-year contract with the United States Air Force through the Air Surgeon's Office and the Air Materiel Command to study exhaustively effects of Arctic operation with respect to human physiology and biophysics, comparative physiology, and psychology. The contract provides for several major projects at the University and Ladd Field and for supporting work there or elsewhere pertinent to Arctic operational conditions. The Department of Physiology and Biophysics will welcome proposals for research of this character. It is the endeavor of the present investigators to determine the effects of cold on the response of the human to other stresses and strains such as exercise, lack of food, etc. It is proposed to survey critically the field of comparative physiology to determine how other animals respond to similar stress. The Psychology Department will investigate all facets of the problem of interest in psychology and to which psychology can contribute. Investigators and young men in the fields of physiology, physics, and psychology who are interested in this work may contact Prof. L. D. Carlson in Seattle, Washington.

Stanford Research Institute has recently added 53 people to its staff, among whom are Richard Pencharz, cancer expert, and John W. Edgemond, Jr., inventor. As senior biologist, Dr. Pencharz will do research in the life sciences field. Mr. Edgemond has been appointed chairman of the Department of Applied Mechanics.

Associated Universities, Inc., recently appointed Frank D. Fackenthal, former acting president of Columbia University, as its new president. Dr. Fackenthal assumed his duties November 19 at the first meeting of the newly-elected Executive Committee of AUI, which includes: I. I. Rabi, Columbia University; Franklin A. Long, Cornell University; A. Baird Hastings, Harvard University; Peter Stewart Macaulay, Johns Hopkins; William H. DuBarry, University of Pennsylvania; and Edmund W. Sinnott, Yale University. Associated Universities administers the $50,000,000 Brookhaven atomic energy project under contract with the AEC.

A Department of Biophysics has been established at the University of Colorado Medical Center in Denver. A graduate program leading to the Ph.D. degree in biophysics is to be offered in the new Department, which will be headed by Prof. Theodore Puck, formerly of the Departments of Medicine and Biochemistry, University of Chicago. Courses of instruction include training in the use of radioactive isotopes in biology, interactions of ionizing radiations with living systems, study of the behavior of biologically important macromolecules, and biostatistics. The Department will also participate in the AEC's program for postdoctoral training in biophysics. A research program centering about cellular growth processes and study of the radiation chemistry of artificially-induced mutations is now being set up.

Boston University has been awarded two $1,500 graduate research fellowships by the Kendall Company, of Boston. Both are to begin with the term opening January 31, 1949. One fellowship, in the field of physical chemistry, will investigate the behavior of high-polymer films; the other is for research on the reactivity of certain resin-forming monomers.

The Harold B. Cutter Memorial Committee, under the chairmanship of Joseph J. Jasper, professor of chemistry at Wayne University, has recently been formed to establish and administer the Cutter Memorial Fund, which will provide an annual award for students in organic chemistry. The Fund is in memory of Dr. Cutter, chemistry professor at Wayne, who died last July 27.

Industrial Laboratories

A new photographic emulsion developed in the Kodak Research Laboratories by John Spence and Gordon Shayler for tracking down atomic particles is of such sensitivity that its producers are now faced with the problem of how to prevent its premature exposure by cosmic rays during shipment to research workers. No sooner is the emulsion made than it begins to record the bombardment of cosmic rays. According to Cyril Staud, laboratory director, "about six electrons from cosmic rays strike each square centimeter of the emulsion every minute." Therefore, unless adequately protected, in three days time this intense barrage causes the emulsion to be clouded with background streaks upon development. When the emulsion becomes generally available, it may be possible, Dr. Staud states, to protect it during shipment by packing it in dry ice.

A supersonic parachute, or "rotochute," which can safely lower instruments from rockets flying as high as 100 miles, has been developed in General Electric's General Engineering and Consulting Laboratory from an invention by I. B. Bensen. Blown free at the peak of a rocket's trajectory, the device can brake the equipment's rate of fall from the original supersonic speed to a landing speed of 27 mph. The most successful model measures about 4′ long by 8″ wide and has a propeller or vanes, about 8′ long, which begin to revolve as they fall into denser air until they are horizontal. The high-altitude rockets for which the rotochute is devised are now being fired at White Sands, New Mexico, as part of GE's rocket-research program being conducted by the Army Ordnance Department.

Meetings and Elections

Program details for the meetings of the Science Teaching Societies affiliated with the AAAS in Washington, D. C., December 27–30, have just been announced by R. H. Carleton, executive secretary of the NSTA. Meetings will be held in the Washington and Willard Hotels.

Morning sessions December 28, 29, and 30 will be conducted jointly by the cooperating societies: The American Nature Study Society, The National Biology Teachers Association, The National Science Teachers Association, and Section Q (Education) of the AAAS. Topics include: De-

cember 28, Panel Discussion: "Curriculum Development in Science"; December 29, Panel Discussion: "Problems of Science Teacher Training"; December 30, Third Annual Junior Scientists' Assembly.

At the Joint Banquet on Wednesday, December 29, Paul C. Aebersold, chief of the Isotopes Division, Oak Ridge Operations, will discuss "Atomic Energy in a Peacetime Economy."

The second Conference on Industry-Science Teaching Relations will be conducted Tuesday, December 28, by the NSTA. Miles J. Martin will discuss "Research Highlights of Interest in the Classroom"; Thomas J. Sinclair will report research on "Factors Relating to Business-sponsored Teaching Material"; and Morris Meister wil report on "A Year of Collaboration Between Industry and Schools." Further research to be conducted on Industry-Science Teaching Relations problems will be discussed. Some 200 representatives of business and industry are expected to participate.

A panel of the American Nature Study Society will discuss "Conservation Issues Today" on Wednesday, December 29. Participants include Devereaux Butcher, Ira C. Gabrielson, William Vogt, Ruth Gilmore, and Howard Zahnizer.

The question, "How Can the Teaching of Health Become a Factor in the Improvement of Human Relations?" will be discussed by Mrs. Albert Martin, John E. Schoop, and H. B. Wightman before the National Biology Teachers Association on Thursday, December 30.

Copies of the complete program may be obtained from R. H. Carleton, Executive Secretary, National Science Teachers Association, 1201 16th Street, N. W., Washington, D. C.

The 80th meeting of the American Astronomical Society will be held December 28–31 at Yale University. Thursday afternoon a special symposium on microwave astronomy is scheduled under the direction of Charles R. Burrows, head of the School of Electrical Engineering, Cornell University. This will be followed by a Teachers' Conference on the current problems facing astronomy instructors. After the Society dinner that evening, the following speakers will discuss various aspects of the 1948 meeting of the International Astronomical Union at Zurich: Harlow Shapley, Harvard Observatory; Dirk Brouwer, Yale Observatory; Gerald M. Clemence, U. S. Naval Observatory; and Otto Struve, University of Chicago.

An International Conference on the Northwest Atlantic Fisheries will be convened January 26 in Washington, D. C., by the U. S. Government, for the purpose of discussing the development of means for formal international cooperation in the investigation and, where necessary, the conservation of fishery resources of these waters. According to the Department of State, through which arrangements are being made, invitations have been sent to Canada, Denmark, France, Iceland, Italy, Newfoundland, Norway, Portugal, Spain, and the United Kingdom.

A symposium on "Science and Civilization" is being sponsored by the University of Wisconsin's History of Science Group, January 13–15, as part of the University's Centennial Anniversary. The first session, scheduled at Wisconsin's Memorial Union on Thursday afternoon, January 13, will be concerned with the "Origins of Science." Richard P. McKeon, University of Chicago, will speak on "Aristotle and the Origins of Science," and Lynn Thorndike, of Columbia University, will discuss "Some Unfamiliar Aspects of Medieval Science." Details of the remaining sessions are as follows: second session, Thursday evening, on the "Philosophy of Science," with addresses by Max Black, Cornell University, and Ernest Nagel, Columbia University; third session, Friday morning, discussion of four preceding addresses by specialists from neighboring universities; fourth session, Friday afternoon, on "Physics as a Cultural Force," with addresses by Karl Lark-Horovitz, Purdue University, and Philipe LeCorbeiller, Harvard University; fifth session, Friday evening, with addresses by Owsei Temkin, Johns Hopkins University, on "Science and Life," and by Wm. F. Ogburn, University of Chicago, on "Science and Society." The symposium will conclude Saturday morning, January 15, with a general discussion of the four Friday papers.

R. C. Stauffer, History of Science Department, University of Wisconsin, Madison, is acting as chairman of the symposium committee, and further details regarding the sessions and hotel accommodations may be obtained from him. Hotel reservations, however, must be made directly through the hotels.

The Fifth Annual Conference on Protein Metabolism, sponsored by the Bureau of Biological Research, Rutgers University, will be held in New Brunswick, New Jersey, on January 28–29, 1949. Three sessions will be arranged on Friday afternoon, Friday evening, and Saturday morning for the presentation of 6 reports on recent investigations. The topics will be: (a) the mechanisms by which amino acids are utilized to form proteins, (b) the interrelationships of the sulfur-containing amino acids, (c) the metabolism of peptides, (d) the role of the animal protein factor, and (e) clinical aspects in cancer and other diseases. The speakers will include David M. Greenberg, Howard B. Lewis, Halvor N. Christensen, Freddy Homburger, W. J. Eisenmenger, and J. W. Huff.

The Conference is open to all interested persons who register by January 12. Registration blanks may be secured by writing to Prof. William H. Cole, Rutgers University, New Brunswick, New Jersey.

The Indiana Academy of Science held its 64th annual fall meeting October 28–30, with Indiana University, Bloomington, as the host institution. Scientific papers were presented, and a banquet was held. W. A. Daily, press secretary, reports that the presidential address was delivered by Winona Welch and that the two annual prizes given for outstanding work were presented to Clyde A. Malott, Indiana University, in geology, and Ed. F. Degering, Purdue University, in chemistry.

Officers elected for 1949 are: president, C. L. Porter, Purdue Univer-

; vice-president, S. F. Visher, liana University; secretary, O. B. risty, Ball State Teachers College; asurer, W. P. Morgan, Indiana tral College; editor, E. S. Gantz, rdue University; and press secre-y, W. A. Daily, Butler University. The 1949 fall meeting will be at abash College, Crawfordsville.

The 49th Annual Convention of e Society of the Sigma Xi was held Cleveland on November 27. Peti-ns for the establishment of chap-s at Oklahoma A & M College at illwater and at Temple University, iladelphia, were granted.

The newly elected officers include: orge B. Pegram, Columbia Univer-y, president; George A. Baitsell, le University, executive secretary; nald B. Prentice, past-president of ee Polytechnic Institute, treasurer; B. Allen, University of Washing-n, member of the Executive Com-ittee. Frank M. Carpenter, Har-rd University, was elected to the embership Committee.

An important and largely attended ientific program was presented in e Ball Room of the Hotel Cleveland the evening of November 26. rticipants included Harlow Shap-y, Harvard University; Arnold L. sell, Yale University; and Bradley Patten, University of Michigan. lso, the new California Institute of chnology film describing the Palo-r Observatory was shown through e cooperation of Carl D. Anderson, tional president. The chairman of e local committee was Dean Elmer tchisson, of Case Institute of Tech-logy.

The Springfield Chapter of the AAS reports a most successful meet-g on November 4. The program s broken into an afternoon and ening session with an intervening nquet. Keynote of the meeting as "The Atomic Energy Program." ollowing an introduction by M. areus Kiley, principal of Technical igh School, Clayton F. Holoway, rofessor of chemistry, Springfield llege, presented the welcoming ad-ess.

Section chairmen included Ralph T. azzaro, professor of chemistry, Col-ge of Our Lady of Elms; Nora M. Mohler, professor of physics, Smith College; C. Rice Gadaire, professor of biology, American International College; and I. Jacques Yetwin, chairman of the Springfield Chapter.

"Introduction to Atomic Energy," by William H. Ross, "Instrumentation and Industrial Applications of Radioactivity," by Cyril H. Brown, and "Biological Research at Brookhaven National Laboratory," by Leslie F. Nims, constituted the principal lectures. Special exhibits and demonstrations, including motion pictures, illustrated the development and use of atomic energy.

The program ended with a Symposium on Atomic Energy.

Included among the institutions sponsoring this meeting, which was attended by several hundred persons, were: American International College, Springfield; Amherst College, Amherst; Bay Path School, Longmeadow; Hillyer College, Hartford; Mount Holyoke College, South Hadley; College of Our Lady of Elms, Chicopee; Smith College, Northampton; Springfield Academy of Medicine; Springfield College; Trinity College, Hartford; University of Massachusetts, Amherst; and Westfield State Teachers College.

Philip H. Cinis, secretary-treasurer of the Chapter, reports plans for three meetings during the coming year.

NRC News

Merck Postdoctoral Fellowships in the Natural Sciences will again be offered to young men and women who have demonstrated marked ability to do research in chemical or biological science and who wish to broaden their fields of investigational activity. All fields of chemistry and biology, including the preclinical medical sciences, are open to applicants. Recognizing that many scientific problems in these fields are of such complexity that a thorough grasp of more than one discipline is required for satisfactory approach toward their solution, special consideration will be given to those applicants who wish to supplement mastery in one field by competence in another. Fellowship awards are made for study and research in this country or abroad.

A Fellow must be a citizen of the United States, under 35 years of age, and must have training in chemistry or biology equivalent to that represented by the Ph.D. degree. He or she must also have demonstrated unusual talent for experimental research.

Fellowships will be awarded by the Merck Fellowship Board at a meeting to be held in March 1949. Applications to be considered at that meeting must be filed before *January 15*, 1949. Unless otherwise arranged, tenure will begin on July 1, 1949.

National Research Fellowships in the Natural Sciences will also be continued in 1949. These fellowships, designed to promote fundamental research in the natural sciences, are awarded to citizens of the United States or Canada and generally only to persons under 35 years of age. The requirements for the doctorate must have been completed prior to assuming the fellowship, and the Fellow must have demonstrated a high order of ability in research.

Fellowships will be awarded by the Natural Sciences Fellowship Board at a meeting to be held in March 1949. Applications to be considered at this meeting must be filed on or before *January 1*, 1949. Tenure of the fellowship may begin at any appropriate time after the Board meeting.

Further information concerning these fellowship programs may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C.

The NRC, which also administers the AEC Fellowship Program, also wishes to announce that the following will be available for the year 1949–50:

AEC Predoctoral Research Fellowships in the Biological and in the Physical Sciences: These are open to both men and women and are designed to provide graduate training and research experience leading to the doctorate. Any research problem in the biological or physical sciences which, in a broad sense, is basic to atomic energy or associated with the development of atomic energy or its by-products may be undertaken under these fellowships.

A Fellow must be a citizen of the United States, under 35 years of age at the time of appointment, and must have demonstrated ability and aptitude

for advanced training. In the physical sciences he or she must have had at least one year of graduate training prior to assuming the fellowship, but for the biological sciences only the bachelor's degree is necessary.

Medical students who wish to acquire training in research techniques are eligible for the predoctoral biological fellowships. They must, however, take a year's leave from their medical training between the sophomore and junior years or the junior and senior years in order to pursue the fellowship.

AEC Postdoctoral Research Fellowships in the Physical Sciences and in the Biological and Agricultural Sciences: These are designed to provide advanced training and research experience for men and women desiring to enter upon careers in fields related to atomic energy. Any field of the biological or physical sciences in which nuclear phenomena are involved is open to applicants.

A Fellow must be a citizen of the United States and under 35 years of age at the time of appointment. He or she must have had training in some branch of the biological or physical sciences equivalent to that represented by the Ph.D. or Sc.D. degree and must have demonstrated superior ability for research.

Fellowships in these four programs will be awarded by the AEC Fellowship Boards at meetings to be held in March 1949. Applications to be considered at these meetings must be filed before *February 15*, 1949. Tenure of fellowships may begin at any appropriate time after the Board meetings.

Further information concerning these fellowships may also be obtained from the NRC Fellowship Office.

An aerial view of the new Michelson Laboratory of the U. S. Naval Ordnance Test Station, Inyokern, California, appears on this week's cover. In dedication ceremonies last May, a large audience heard Robert A. Millikan, professor emeritus of physics at the California Institute of Technology, present the memorial address in honor of the late Albert A. Michelson, graduate of the Naval Academy and America's first Nobel laureate in physics. On this occasion the Medal of Merit was presented to Charles C. Lauritsen, who directed the rocket program at the California Institute of Technology from 1940 to 1946. The Laboratory is located at China Lake, California, in the Mojave Desert, about 160 miles northeast of Los Angeles, and is a facility of the Naval Ordnance Test Station, which encompasses over 1,000 square miles, or roughly the size of Rhode Island. More than 12,000 live in the community on the Station, and all buildings are air-conditioned to eliminate discomfort from the summer temperatures which often rise to over 100 degrees. The commanding officer of the Station is Rear Adm. W. G. Switzer. The primary function of the Station is the research, development, and testing of weapons, with special emphasis on the development of rocket weapons, guided missiles, and aviation ordnance. The Technical Staff is directed by L. T. E. Thompson.

"Adventures in Science," discussions of current developments in science produced by the Columbia Broadcasting System in cooperation with Science Service, may again be heard on Saturdays from 3:15 to 3:30 P.M. (EST) over the CBS network. The program, which had been off the air for 11 weeks, resumed on December 11. During 1949 Watson Davis, director of Science Service, and his guests will observe this mid-century year by highlighting the scientific needs calculated to confront the world during the next half-century. The December 18 program will include Mr. Davis' annual summary of progress made in science during the preceding year together with a discussion of titanium by I. H. Kramer and J. J. Harwood, of the Office of Naval Research.

The American Bryological Society is the name recently adopted by the Sullivant Moss Society. Its journal, *The Bryologist*, now in its 51st volume, is currently edited by W. C. Steere, of the University of Michigan. Both the journal and the Society were started by the initiative of the late A. J. Grout in 1898. The Society was informally organized under the name Sullivant Moss Chapter of the older Agassiz Association of various natural history societies. Today, the membership is international in representation and consists, exclusive of institut memberships, of about 200. American Bryological Society m tains permanent herbaria for lich hepatics, and mosses, with C. Dodge, Missouri Botanical Gar Margaret Fulford, University of cinnati, and Lewis E. Anderson, I University, serving as curators, res tively. The Society also maint two active Exchanges, one for mo and the other for hepatics. Pre officers are: president, Paul M. terson, Hollins College, Virginia; v president, Roy F. Cain, Univer of Toronto; and secretary-treasu Winona H. Welch, De Pauw Uni sity.

Recently Received:

Conservation in Micronesia: a re on two conferences held under auspices of the Pacific Scie Board in Honolulu, T. H., Washington, D. C., in April May 1948. Compiled by Harol Coolidge, executive secretary of Board. Washington, D. C.: tional Research Council, 1948.

The clinical use of crystalline pen lin G sodium Merck. Booklet pared by Merck & Co., Inc., Rah New Jersey, for distribution to medical profession.

Proceedings of the staff meetings the Mayo Clinic. Published f nightly by Mayo Foundation Medical Education and Resea Rochester, Minnesota.

Highway Research Abstracts. P lished monthly except August by Highway Research Board of National Research Council. An subscription, $3.00; single cop $.30.

Micromax Model S indicating rec ers and controllers. (Cat ND44(1), 1948.) Issued by Le & Northrup Company, 4907 Ste Avenue, Philadelphia 44, Penn vania.

Stanford Engineering News. P lished by the Stanford Engineer School.

Challenges and opportunities in wo health: the First World Hea Assembly, by H. van Zile Hy (Department of State Publ. 33 Washington, D. C.: U. S. Gov ment Printing Office, 1948. $